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A STUDY OF SPACE STATION NEEDS, ATTRIBUTES & ARCHITECTURAL OPTIONS

FINAL REPORT VOLUME II • TECHNICAL BOOK 1 • MISSION REQUIREMENTS APPENDIXES I & II

22 April 1983

Submitted to
National Aeronautics and Space Administration
Washington, D.C. 20546

Prepared by GENERAL DYNAMICS CONVAIR DIVISION P.O. Box 85357 San Diego, California 92138

APPENDIX I

MISSION REQUIREMENTS DATA BASE

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MISSIONS	NUMB	ER RANGE
Hadasand	FROM	TO
		-
SECTION 1 SCIENCE AND APPLICATIONS MISSIONS	0000	0999
1.1 Astrophysics	(0000)	(0099)
Astronomy	0000	0029
High Energy (Cosmic-Ray, Gamma-Ray, X-Ray	0030	0059
Solar Physics	0060	0099
1.2 Earth and Planetary Exploration	(0100)	(0199)
Planetary Observations	0100	0119
Solar System Missions	0120	0139
Earth Dynamics	0140	0149
Crustal Motion	0150	0159
Geopotential Fields	0160	0169
Earth Resources	0170	0199
1.3 Environmental Observations	(0200)	(0299)
Weather/Climate	0200	0219
Ocean	0220	0239
Solar/Terr:strial	0240	0259
Atmospheric Research	0260	0279
1.4 Life Sciences	(0300)	(0399)
Biological Science	0300	0319
Operational Medicine	0320	0339
Life Support	0340	0359
1.5 Materials Processing	(0400)	(0499)
SECTION 2 COMMERCIAL MISSIONS	1000	1999
2.1 Earth and Ocean Observations	(1000)	(1099)
2.2 Communications	(1100)	(1199)
2.3 Materials Processing	(1200)	(1299)
2.4 <u>Industrial Services</u>	(1300)	(1399)
SECTION 3 TECHNOLOGY DEVELOPMENT	2000	2999
3.1 Materials & Structures	(2000)	(2099)
3.2 Energy Conversion	(2100)	(2199)
3.3 Computer Science & Electronics	(2200)	(2299)
3.4 Propulsion	(2300)	(2399)
3.5 Control & Human Factors	(2400)	(2499)
3.6 Space Station Systems/Ops	(2500)	(2599)
3.7 Fluid & Thermal Physics/PACE	(2600)	(2699)
	, ,	(=====
SECTION 4 OPERATIONS	3000	4999
4.1 Maintenance 4.2 Other	(3000)	(3999) (4999)

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INTRODUCTION

- Guidelines for Preparation of NASA LaRC Payload Element Data Descriptions
- Guidelines for Preparation of Payload Element Operations Descriptions
- Guidelines for Preparation of Payload Element Synthesis Data

DATA SHEETS

- Science and Applications Missions
- Commercial Missions
- Technology Development Missions
- Operations Missions

INTRODUCTION

The Space Station Mission requirements data base consists of 149 attached and free-flying missions each of which is documented by a set of three interrelated documents as shown in Figure 1-1:

- Type A NASA LaRC Data Sheets with three sheets comprising a set for each payload element described. These sheets contain user payload element data necessary to drive Space Station architectural options.
- Type B GDC-derived operations descriptions that supplement the LaRC payload element data in the operations areas such as further descriptions of crew involvement, EVA, etc. One operations sheet is provided for each payload element.
- Type C Payload elements synthesis sheets used by GDC to provide requirements traceability to data sources and to provide a narrative describing the basis for formulating the payload element requirements. One or more synthesis sheets are provided for each payload element identified.

The data base has been developed for the set of 149 missions that are categorized and tabulated in ascending order in this appendix. Each of the payload elements is documented by a package consisting of all three types of data items identified above. A minimum of five descriptive data sheets is contained in each "package" - three LaRC summary data sheets, one operations description data sheet, and one or more payload synthesis sheets. The following paragraphs describe the content and preparation guidelines for each type of data sheet in further detail.

It should be noted that the payload elements contained in this appendix are described in terms of their prefered accommodation mode. If a payload is alternatively accommodated in an acceptable mode, the physical characteristics may change, e.g., a pointing mount that is part of an attached payload may be eliminated if the payload is alternatively accommodated on a free-flyer that has the required pointing accuracy.

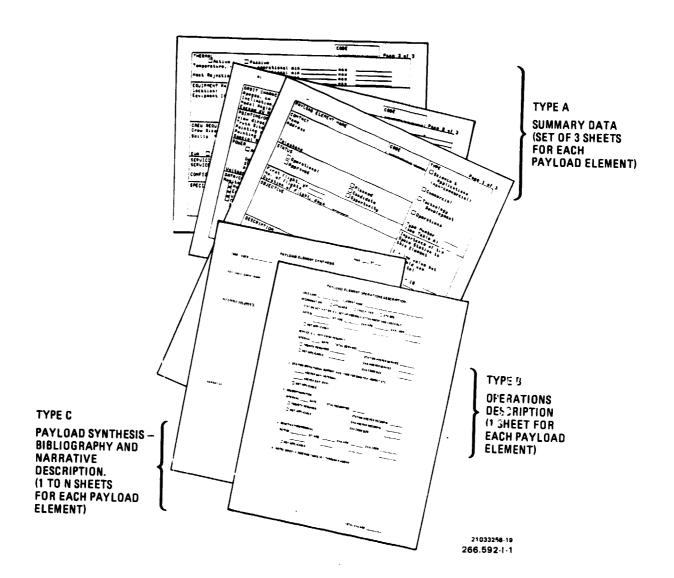
National security payload elements are not discussed in this appendix. Discussion is contained in Volume II Book 4.

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Figure I-1 Payload Element Documentation



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GUIDELINES FOR PREPARATION OF NASA LARC PAYLOAD ELEMENT DATA DESCRIPTIONS

The General Dynamics Convair Division interpretation of selected entries appearing on the NASA LaRC payload element data sheets is described in the following paragraphs and includes any field size, or other limitations that have been provided by LaRC. LaRC data constraints are flagged by an asterisk in the data descriptor title. For convenience the sample blank forms shown have been annotated with reference designators that may be used to key to the following descriptions of the data to be entered in each applicable area.

			Page 1 of
PAYLOAD ELEMENT NAME	1 0 6	OE O	TYPE
CONTACT Name 4			Applications (non-commercial)
nuu			Commercial 3
Telephone (5)			Technology Development
STATUS (6) Operational	Planned		Operations
☐ Approved	☐ Candidat ☐ Opportus		Type Number
First flight, yr 7 No. of flights 2 Duration of Flight, day	<u>. </u>		Importance of the Space Station to
OBJECTIVE			this Element
(10		1 - low value but could use 10 - vital
		•	Scale 1 - 10 12
DESCRIPTION			
	11		
			266.592-1-2

266.592-1-4

			CODE	① .	
ORBIT CHARACTERISTICS	-				. s • ()
Apogee, km(3) Peris	jee, km	Tolor			<u>w</u>
Nodal Angle, deg		Tolerance + Ephemeris Ac			
Escape du Required, m/s					
POINTING/ORIENTATION	Airl Dealan	- De41			
Uiaw direction(17) ☐ Iner Truth Sites (16 known)	tial USolar	(Bart)			
Pointing accuracy, arc se	<u> </u>	Fre fq of Are	w, deg		
Pointing Stability (Jit Special Restrictions (Av	ter)erc sec/sec	20 _ 20 			
POUER_ (2) _					
□ AC □ DC	Daman II	Summatum hm	a eda		
Operating	Power, U	Duration, hr	- szaky		
Standby				□ Cont1	nuous
Paak Voltage, V	Freque	cu . Hz			
DATA/COMMUNICATIONS					
Monitoring requirements:		□ Jther	(3)		
UNone □Realtim □Encryption/Decryptio		_ Other			
Uplink Req. Command	Rate (KBS)		_Frequency	(MHZ)	
UOn-Board Data Proces	sing Kequired				1
Omscription (8)					
Data Types: Anal	og 🗆 Digiti	l OHre/D)ay		
Film (Amount) Live TU (Hrs/Day)		Voice (Hrs/D	V (25)		
	IT)				
Data Dump Frequency Recording Rate (KBPS)	Downlink Fra	guency (MHZ		
				26	6.592-1-3
			CODE G.D.C.D.	2) Pag	<u>. 3 of</u> 3
THERMAL (2) Pass					
	perational min.		_ max		-
non-o	perational min.		- <u> </u>		-
	porational min.		#8X		
EQUIPHENT PHYSICAL CHARA	CTERISTICS _	. @			
Location: UInternal Equipment ID/Function	External L Pressurized	Remote 🗢	ad (29)		
L,m	(30) U , m	(30) H, m		Stowed	}
l.m	(31). U , m	<u>~</u> 31−H, m	(31) <u>—</u>	Deploy	ed
	h mess, kg mebles Types		(32)	<u> </u>	1
Accel	ration sensiti	lvitu, a min		8x <u> </u>	
CREU REQUIREMENTS	Task As	signment	38		
Skills (See Table B)	SKILL 3	A THE STATE OF THE			T
***************************************	LEVEL	3			
	Hrs/Dau	<u> </u>	J		1
EUA OTYES DNO	Reason		_Hrs/EUA	<u>(v)</u>	
SERVICING/MAINTENANCE SERVICE: Interval, days		Consumables	. ba		
Returnables, kg		Man Hours	' <u>**</u> @	(1)	
CONFIGURATION CHANGES: In			_Man/Hrs Re	- 	
SPECIAL CONSIDERATIONS/S	<u>liverables, ka</u>	4	_Returnable	7 3 , K () , war	
_	DB THREATON	•			İ
•					

DATA DESCRIPTORS

Payload Element Name* - Descriptive title (32-character limit)

The state of the s

Code* - Enter 4-digit identifier, GDCD XXXX on each data sheet as follows:

4-DIGIT IDENTIFIER*

Туре	Number Range
Science and Applications Commercial Technology Development Operations Other National Security	0000-0999 1000-1999 2000-2999 3000-3999 4000-4999 5000-5999

(3.) Type* - Select the most appropriate payload element type and enter the most appropriate single type number designator from Table A.

Table A Payload Element Type*

SCIENCE AND APPLICATIONS

- Astrophysics
 Earth and Planetary Exploration
- 3. Environmental
- 4. Life Sciences
- 5. Materials Processing

COMMERCIAL

- 6 Earth and Ocean Observations
- 7. Communications
- 8. Materials Processing
- 9. Industrial Services

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TECHNOLOGY DEVELOPMENT

- 10. Materials and Structures
- 11. Energy Conversion
- 12. Computer Science and Electronics
- 13. Propulsion
- 14. Controls and Human Factors
- 15. Space Station Systems and Operations
- 16. Fluid and Thermal Physics, Physics, and Chemistry

OPERATIONS

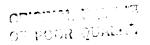
- 17. Maintenance
- 18. Other
- 4. 5. Contact Name, Address, Telephone* Enter the following standard.

 (Name, 1 line, 32-character limit; address, 4 lines, 24-character/line limit; telephone, 1 line, 32-character limit)

W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair P.O. Box 85357 San Diego, CA 92138 (619) 277-8900, Ext 3778/2130

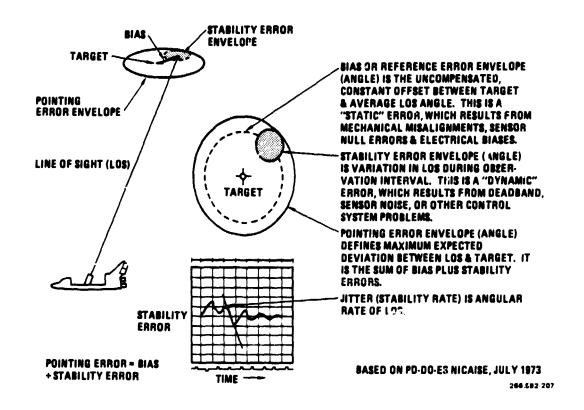
- 6. Status The single most appropriate category. Reserve "approved" status for those payload elements appearing as line itmes on the current NASA budget.
- 7. First Flight Initial launch year. If more than one launch is required, enter the other launch dates elsewhere on the data sheet. For a mission launched before the Space Station era (before 1990) and still in operation during the 1990-2000 decade, show the initial launch date. For a mission launched before 1990 but returned to earth for refurbishment and relaunched, enter the later launch date after which Station interfacing operations will occur. (NOTE: The first flight date reflects the baseline mission data set prescribed in Volume II, Book 1, Section 4-4 and has in some cases been slipped from the user desired data as described in Book 1, Section 3-4.)
- 8. Number of Flights The total number of flights required to accomplish the mission objectives. Does not account for multiple flights to deliver an oversize payload element, or multiple flights for service, or flights for earth return.
- 9. Duration of Flight Mission duration for the initial launch. If different mission durations for subsequent flights, describe elsewhere on the data sheet.
- 10.) Objective* (7 lines, 72-characters/line limit)
- (11.) Description* (9 lines, 108-characters/per line limit)

- 12. Importance Values near 1 indicate a benefit. Values near 10 show that the Space Station is vital to accomplishment of the objective of the mission. Values between 1-10 reflect the degree of significance judged appropriate.
- 13. Preferred Orbit Preferred orbit apogee and perigee altitude and inclination. If not critical, ANY is entered. If Space Station altitude is preferred, enter LEO.
- 14. 15. Acceptable Orbit The tolerance from the perferred orbit characteristic denoting the acceptable range of orbit altitudes and inclinations that will permit the primary payload objectives to be accomplished. Some degradation ir overall mission results may occur.
- (16.) Escape dV Required For planetary payload elements only.
- 17. Viewing Direction Desired viewing direction or orientation, i.e., inertial, solar or earth. Any other appropriate direction requires explanation, and is recorded as "special considerations". item 44.
- 18. Truth Sites* Truth site description, e.g., location, type, etc. (60-character limit).
- Pointing Accuracy The required pointing accuracy at the interface between the instrument and its carrier. Where the payload definition includes a pointing mount, the accuracy required at the base of the mount is typically 30 to 60 arc minutes (see Figure I-2).
- 20. Pointing Jitter The maximum allowable angular rate of the line-of-sight (see Figure I-2).
- 21. Special Restrictions (Avoidance)* Describe pointing constraints (50-character limit).
- Power Describe the input power level and duration when operating, peak power input level and corresponding time, or other power related parameters. For a payload element attached to the Space Station, the power matches the integrated payload definition at the interface. For free-flyers the power level can be for the science payload and/or spacecraft while operating, or, if known, the power level while attached to the Station for service/checkout.
- (23.) Data Monitoring Requirements* Other requirements (30-character limit).
- (24.) On-Board Data Processing Description* (80-character limit).
- 25.) Other Data Types* (30-character limit).
- (26) Recording Rate The ditigal data rate flowing from the payload (including both science and housekeeping data) whether recorded or not.



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Figure I-2. Line of Sight Error Definition



- 27. Thermal The thermal characteristics needed by the payload equipment at the interface with the Space Station (unless otherwise specified, e.g., the payload requirements for a free-flyer).
- 28. 29. Equipment Location, ID, Function The primary equipment location, e.g., external/unpressurized. If equipment is both pressurized and unpressurized, explain the secondary equipment elsewhere in the data sheet.
- 30. Stowed Dimensions The estimated dimensions when stowed for delivery in the Shuttle cargo bay with length (L) axis corresponding to cargo-bay longitudinal axis. If cylindrical shape, enter width (W) and height (H) as same dimension.
- Deployed Dimensions The envelope dimensions of payload equipment mounted internally or externally to the Station or in the free-flying configuration when the equipment is fully deployed, erected, or constructed. Unless otherwise specified, excludes consideration of crew access volume, aisle space, or other packaging effects.
- 22. Launch Mass Normally the mass of the payload equipment as defined for the expected accommodation mode, e.g., the payload weight for a station-attached payload, which could include: a mounting structure, power and signal interface units, cold plates and coolant pump packages, and appropriate instrument pointing system or merely the individual instruments or instrument groups. For free-flyers the mass may be for either the integrated instrument package or complete spacecraft/scientific equipment weight; or the total upper stage payload weight ("throw" weight), which includes satellite subsystem.
- Consumables Type* Usable materials included in Launch Mass, e.g., spacecraft propellants (30-character limit).
- Acceleration Sensitivity: The highest permissible acceleration level during critical periods of experiment or processing operations. This is relatively long term, unidirectional acceleration as induced by atmospheric drag, drag, stationkeeping or reboost thruster operation, or relation for reorientation.
- 35. Crew Size The minimum number of crew persons required simultaneously to support routine payload operations.

- 36. Task Assgnment The critical function(s) performed by the crew to support routine payload element operations.
- 37. 38. Skill Type, Skill Level* The minimum skill requirements to perform the mission objectives. If more than one, specify each in accordance with Table B. (Note: more than one skill does not necessarily imply more than one crew person, since cross-training at acceptable levels is assumed).

CREW SKILLS*
Table B

Skill Type

- 1. No Special Skill Required
- 2. Medical/Biological
- 3. Physical Sciences
- 4. Earth and Ocean Sciences
- 5. Engineering
- 6. Astronomy
- 7. Spacecraft Systems

Skill Levels

- 1. Task Trainable
- 2. Technician
- 3. Professional
- 39. Crew Time The total number of hours per day devoted to planned payload operations. This is an average over the mission duration.
- EVA/Reason* An x check indicates that EVA is required for the reason noted, e.g., to set up, operate, service, and/or reconfigure or tear down the payload equipment (the EVA reason is limited to 20 characters).
- 41. HRS/EVA Interpreted to be the summation of EVA hours for all mission EVA-related operations to include, for example, the EVA portion of all reconfiguration or service operations conducted throughout the mission lifetime.

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- Service (Manhours) The total number of manhours estimated for a single service operation. Manhours for service can include both IVA and EVA time. If EVA time is needed, the total EVA time for all the service operations during the mission are totaled and included in item 41. The total number of servicing operations may be derived from the service interval and mission duration, or by consulting the related operations data sheet.
- 43. Reconfiguration (Manhours) The same concept described for service operations manhours applies to reconfiguration operations manhours.
- Special Considerations* Includes special requirements or other pertinent information about payload configuration, resources, multiple payloads, etc., and includes the following examples: (6 lines, 108-character/line limit).

Examples of this category*

Special environmental criteria Special servicing or support requirements Unique operational characteristics Orbit changing needs Safety considerations

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GUIDELINES FOR PREPARATION OF PAYLOAD EL MENT OPERATIONS DESCRIPTIONS

Operations data captured in the Payload Element Operations Description data sheet is intended to augment the data contained in the NASA LaRC documentation. GDCD code numbers and payload element names are the same. The total EVA hours at the bottom of the operations sheet is the sum of all the EVA hours and corresponds to the entry on the third LaRC data sheet. Accommodation is the user preferred mode. Requirements for OTV/TMS are noted only when required by the mission, e.g., for geosynchronous orbit placement, however, derived requirements for use of specific elements (such as TMS for servicing) are not precluded in subsequent accommodation analyses.

A sample operations data sheet format has been annotated with reference designators to provide a key to the following descriptions of data to be entered on the sheet for each payload element.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE ELEMENT NAME	
ACCOMODATION: ATTACHED FREE F	LYER CTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/AT	
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY) INTERVAL (2.1) DAYS TOTAL SERVICES	2.2
TMS/OTV REQUIRED	STATION HRS PER SERVICE
☐ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR 3.1 HRS PER DAY (INTERNAL) 3.2 HRS PER DAY (EVA) NOT APPLICABLE 4. RECONFIGURATION INTERVAL 4.1 DAYS TOTAL RECONFIGS	
TMS/OTV REQUIRED	STATION HRS PER RECONFIG. 4.3
□ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL DATE(S) 5.1 INT. HRS. 5.2 EVA	A HRS EVA CREW
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH	5 ABOVE)
	TOTAL EVA HRS
	200.592-1-0

DATA DESCRIPTORS

1. STATION ACTIVATION

- Date. The date after which the Space Station will accommodate and interface with the payload. (Not necessarily the payload first flight date.)
- 1.2 Int. Hrs. Station hours required for initial checkout. If no internal (IVA) hours are shown here, it is because:
 - a) payload is a free-flyer, or
 - b) initial checkout hours are not unique (e.g., assembly) and, therefore, are considered part of normal station operations.
- EVA Hrs. EVA hours required to initially assemble or attach a payload to the Space Station. Routine placement of a payload on a berthing port or similar operations is considered part of station operations. Reference TM-82482, MSFC, April 1982, for typical operations to be assigned to man, man-machine, or machine.
- $\underbrace{1.4}_{1.3}$ EVA Crew. The estimated minimum EVA crew size (not a multiplier of item

2. SERVICE

- (2.1) Interval. The service interval as shown in NASA LaRC data sheets.
- 2.2 Total Services. Total number of service trips over the life of the payload, normally between the years 1990 and 2000.
- Station Hrs Per Service. The time required for the internal crew per service e.g., to control the TMS (or equivalent) for retrieval of free-flyers or for support of EVA. Excludes any station operations support that is not payload peculiar.
- 2.4 EVA Hrs Per Service. The EVA time required per service by the EVA crewmenber(s). EVA is required for manned functions such as reconfiguration as defined in NASA TM-82482, MSFC April 1982, Figure 4. EVA is also assumed for consumables replacement on payloads launched before the TMS becomes available.
- (2.5) EVA Crew Size. The estimated minimum EVA crew required to perform the task. (Not a multiplier of item 2.4.).

3. STATION OPERATIONAL SUPPORT

- (3.1) Hrs Per Day (Internal). The average number of LVA hours the Space Station crew will spend in controlling and monitoring an attached payload over the life of mission.
- 3.2 Hrs Per Day (External). If applicable, the average number of hours that EVA would be required on a continuing and routine payload peculiar task such as daily inspection.

4. RECONFIGURATION

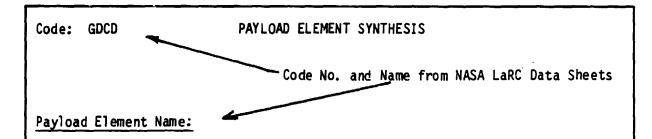
- (4.1) Interval. The reconfiguration interval as shown in NASA LaRC data sheets.
- Total Reconfiguration. The total number of reconfigurations planned for the payload lifetime, normally between the station activation date and the year 2000.
- 4.3 Station Hrs Per Reconfiguration. The payload peculiar time required inside the Space Station to support an individual reconfiguration.
- 4.4 EVA Hrs Per Reconfiguration. The EVA time required per reconfiguration Reference TM-82482.
- 4.5 EVA Crew Size. The estimated EVA crew required to perform the task (not a multiplier of item 4.4).

5. DEACTIVATION/REMOVAL

- 5.1) Date. The date the payload is deactivated or removed from station accommodation. N/A is used if the payload remains to support a later experiment or if payload continues past year 2000.
- 5.2 Int. Hours. Station hours required for special removal and repackaging of payload. Routine removal considered part of station operations.
- (5.3) EVA Hours. EVA hours required for the disassembly of a payload.
- 5.4 EVA Crew. The estimated minimum EVA crew size (not a multiplier of item 5.3.)

GUIDELINES FOR PREPARATION OF PAYLOAD ELEMENT SYNTHESIS DATA

Traceability of requirements is a key factor to the validation of payload element requirements. The payload element synthesis sheet (following) shows the guidelines for preparation of supporting data.



Reference Documents:

Prepare a bibliography of reference documents, meetings, telecons, etc. used as source material to prepare payload element requirements. Be as specific as possible. Include report titles, dates, and page number(s) if applicable.

Narrative:

Describe the payload element synthesis process.

Reference the key requirements data sources (from documents above), and identify assumptions, ground rules, scaling factors, derived data, estimates, augmentation, etc, used to prepare the payload element description on the data sheet. Be as specific as possible in tracing requirements. Attempt to answer the question. "Where did that requirement come from?". Use continuation sheets as necessary.

In addition to payload element synthesis/traceability, this sheet should be used to describe or collect background data and technical features of the payload element which could not adequately be described on the 3-page LaRC data sheets. Reference to the LaRC data entries where appropriate. Attach sketches or whatever would be useful. This sheet may also be used to document overall requirements applicable to more than one payload element within a discipline.

DATA SHEETS

SCIENCE AND APPLICATIONS MISSIONS

Section 1.1

Discipline Astro	physics
------------------	---------

GDCD ID NO.	PAYLOAD ELEMENT NAME
	ASTRONOMY
0000	Starlab
0001	Large Deployable Reflector
0002	Far UV Spectroscopy Explorer
0003	Very Long Baseline Interferometry Demo
0004	Space Telescope
0005	Shuttle IR Telescope Facility
	HIGH ENERGY
0030	Gamma Ray Observatory
0031	High Throughput Mission
0032	Large Area Modular Array
0033	Advanced X-Ray Astrophysics Facility
0034	High Resolution X and Gamma Ray Spectrometer
0035	High Energy Isotope Experiment
0036	Spectra of Cosmic Ray Nuclei
0037	Transition Radiation and Ionization Calorimeter
0038	X-Ray Timing Explorer
	SOLAR PHYSICS
0060	Solar Internal Dynamics Mission
0061	Solar Corona Diagnostics Mission
0062	Advanced Solar Observatory

PAVLOAD ELEMENT NAME Starlab	0 C D 0 0 0 0 E
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division Addross P.O. Box 85357 San Diego, CA 92138	Applications (non-commercial)
Telephone (619) 277-8900, Ext. 3778/2130	Technology
Operational Approved	Tupe
ht, yr 1992 ghts 1 f Flight, days 11	
	this Element 1 - low value could use 10 - vital
	Scale 1 - 10 8
DESCRIPTION The first Starlab mission is to be by Shuttle. Then, it becomes an excellent candidate for Space Station residency. The mode of operation then allows a large significant usage under manual control of station personnel. The facility consists of a telescope with an adaptable focal plane, star tracker, mount, and electronics.	Shuttle. Then, it becomes an excellent operation then allows a large significan he facility consists of a telescope with tronics.

CODE 6.0.0.0.0.0.0 Page 2 of	<u>د</u>
Apogee, km 400 Perigee, km 400 Tolerance + 35 30 Inclination, deg 28.5 Nodal Angle, deg Escape de Regulred.m/s	
ENTATION Solution (If known; tracy, arc sec 150 stilty (Jitter) arc	
Decial Restrict OUER	5
UNICATIONS g requirements; \[\text{Realtime} \times \ti	
Data Types: Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) Downlink Frequency (MHZ)	

CODE 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	C
ational min 2 max 45	 _
Heat Rejection, w operational min max 200	
Sil Remote	
Lunch mass, kg 3280 Consumables Types	
•	
Hrs/Day	
UA LYVES UNO Reason Reconfigure Hrs/EUA 16	
8-1	
Interval, day 360 Man/Hrs Roq.	
CONSIDERATIONS/Sam Instructions	
Condensation sensitive Pointing stability for 30-minute periods	
Hrs/Day 2 No Rouson Reconfigure Hrs/EUA 16 ICE lays Ly kg ESiInterval, day Hours Dollverables, kg Man/Hrs Roq. Dollverables, kg Roturnsbles, kg ONS/See Instructions e r 30-minute periods	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

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GDCD CODE <u>0000</u> ELEMENT N	NAME STARI AR
ACCOMODATION: X ATTACHED] FREE FLYER* 🔲 OTV OPS
I. STATION ACTIVATION (E.G., SET-UP/ASSE	MBLY/ATTACHMENT AND CHECKOUT)
DATE(S) 1992 INT. HRS	EVA HRSEVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SER	RVICES
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG.	TIME FOR MONITOR, INSPECT, ETC.)
2 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	• .
☐ NOT APPLICABLE	
4. RECONFIGURATION	require 2
INTERVAL 360 DAYS TOTAL RI	
TMS/OTV REQUIRED	STATION HRS PER RECUNFIG.
□ NOT APPLICABLE	EVA HRS PER RECONFIG. 8
	EVA CREW SIZE 2
5. DEACTIVATION/REMOVAL	
DATE(S) 1995 INT. HRS.	EVA HRS EVA CREW
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 T	'HROUGH 5 ABOVE)
* Free Flyer accommodation i require re-evaluation of a	s an alternate mode, and if used wil
 Attach to Station - St Pointing control and m Equipment update 	ation OPS

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Code: GDCD 0000

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Starlab

Reference Documents:

 Science and Applications Requirements for Space Station, NASA Hq., P 10, RCVD 11/17/82.

- Astrophysics Project Concept Document, GDC Document No. 10-004H, October 1980.
- 3. Science and Application Space Platform Payload Accommodations Study, SP 82-MSFC-2583, March 1982 p. A-13.

Narrative:

A change from Shuttle payload to station - attached P/L in 1992 is assumed.

Crew time includes some real-time target acquisition plus station processing of data (snapshot), and interaction with ground PI. The crew time and skill are derived, including consideration of international involvement with a number of PI. All crew-related data and payload durations are derived. Pallet-mounted weight and power are from Ref 2. Dimensions are derived from Ref 3. P/L requires station interface for active thermal control, using a freon loop (Ref 3). The payload element provides its own pointing.

Other data based on Ref ! 2, and 3.

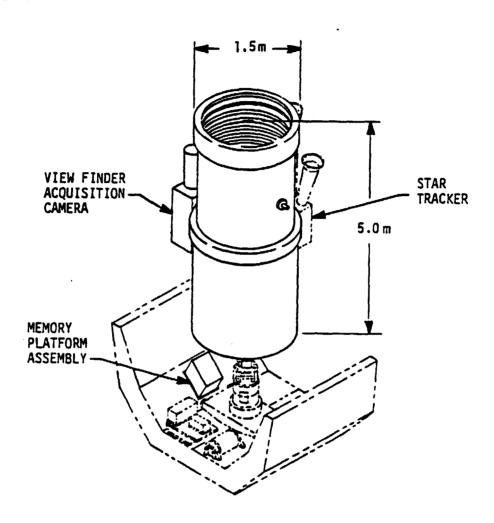
GDC-ASP-83-002

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Code: GDCD 0000

PAYLOAD ELEMENT SYNTHESIS

From Ref 3.



Major Experiment Equipment and Consumables

	Qty	Wt (kg)	Dimension (m)		
Identification/Function			L	W	Н
Telescope	1	1336	5	1.5*	
Camera Module Assembly	1	294			
Electronics Module Assembly	1	104			
Memory Platform Assembly	1	66			
Consumahles:					
Total		1800	*diam	eter	

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Code: GDCD 0000

PAYLOAD ELEMENT SYNTHESIS

From Ref 3.

	MASS (kg)	POWER (W)	ATC	DATA (kbps)		
ITEM	UP/DOWN	OP./PEAK	(W)	SCI	STATUS	CMD
SCIENCE INSTRUMENTS: STARLAB	1800/1800	1400/1900	200	7000	2.0	0.5*
INTEGRATION HARDWARE: Signal Interface Unit (3) Power Interface Unit (1) Pointing System Freon Pump Package S/S Coldplate Experiment Coldplate	30 40 470 63 14 22	75 50 370/1540 325	75 50 315 325	-	TBD TBD (2.0) TBD	TBD TBD (0.5) TBD
CARRIER: Pallet Berthing Adapter Assembly	741 100					
PAYLOAD TOTAL	3280/3280	2220/3890	965	7000	(4.2)	(1.1)

^{*} In command column indicates ancillary data.

Table of Starlab Payload Characteristics

266.592-413

^() TBE estimate.

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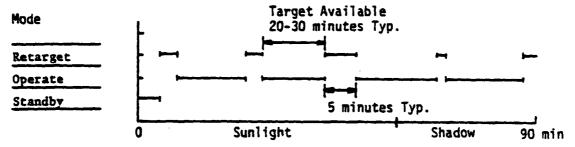
Code: GDCD 0000

PAYLOAD ELEMENT SYNTHESIS

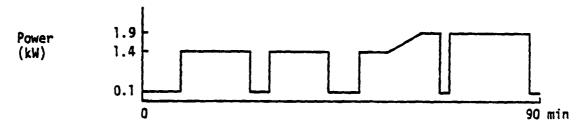
From Ref 3.

Operating Cycle Profiles

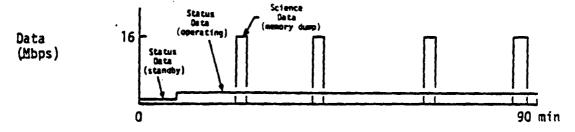
Activity Cycle: For a typical orbit identify type and duration of instrument activities (represent as bars). Describe relationship of activity to target availability, identifiable events, or special conditions (lighting, latitude, magnetic field, etc.).



Power Profile: Sketch in the power levels which correspond to the activities identified above.



Data Profile: Sketch in the data rates which correspond to the activities identified above.



Cycle Repetition (Describe considerations affecting cycle repetition): Target availability is primary driver. Typical exposure times range up to 45 minutes. Two to four targets per orbit is typical. Desire retargeting during orbit day or SAA passage. Objective is to have 2/3 of the time productive. Intermittent calibration sequences are required (order of once per day).

Is coordination with other instruments required? Yes \square No \boxtimes 1f so, describe:

TYPE
X Science &
Applications (non-commercial)
Commercial
Technology Davelonement
Sration Number
(see Table A) Importance of the Space Station to
this Element 1 - low unlue but could use
Scale 1 - 10 4
It will be assembled and the OTV/TMS and is periodically

RBIT CHARACTERISTICS
km 700 ation, deg
OINTING/ORIENTATION Jiew direction Solar Earth
Pointing accuracy, arc sec Field of view, deg Pointing Stability (Jitter) arc sec/sec Special Restrictions (Avoidance)
Operating Standby Continuous Peak
ATA/COMMUNICATIONS Onitoring requirements; Oncorphion/Decryption Requirement R
Data Types: Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) Clive TV (Hrs/Day)
a Dump Freque

200	5							tal
0 1 0 0 1	1	Stowed			80	40	e, kg	SPECIAL CONSIDERATIONS/Sog Instructions Training required for orbital assembly. Strong reasons required for greater than 28.5° orbital inclination. Design of the device at this time is quite nebulous. Two-man EVA assumed for assembly and configuration change; skill 7, level 1, and skill 6, level 2.
CODE 6 0 C 0 0 0 0 1		20	X OE		Hrs/EUA	kg 8 Rog.		for greater t . Two-man EV , level 2.
			gament			103		TONS/See Instructions orbital assembly. Strong reasons required for greater than 28.5° orb f the device at this time is quite nebulous. Two-man EVA assumed for tion change; skill 7, level 1, and skill 6, level 2.
	onal min	TICS brns Remot saurizedX Unpre U, m 20 W, m 20 Types	1 -	n so	Rouson Assy/Config Change	hap	bles, kg	tructions Strong reathis time is all 7, level 1
	X Passive operational non-operational operational non-operational non-operational	ARACT Substance		SKILL LEVEL Hrs/Dau	NO Reaso	E 72 Vs kg Siinterval	Deliverables,	N S/Soc Ins ital assembly he device at n change; ski
	် ၁ ၁	PHYSICAL CHA Internation ID/Function L,m L,m	REQUIREMENTS Size	o Table B)	ONO	TAINTENANCE Lorval, da Lurnables,		45IDERATIO I ired for orbi Design of th configuratior
	THERMAL □Active Temperature, de Heat Rejection,	EQUIPMENT Location: Equipment	CREU REQUIR	Skilla (Soe Table	EUA 🖾 YES	SERVICING/MAINTENANCE SERVICE: Interval, days Returnables, kg CONFIGURATION CHANGES: Interval,		SPECIAL CONSIDERATIONS/Soo Instructions Training required for orbital assembly. Strong rainclination. Design of the device at this time is assembly and configuration change; skill 7, level

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDO	CO CODE_	0001	ELEM	MENT NAME	LARGE [DEPLOYA	BLE REFLECT	OR
ACC	OMODATI	IN: 🗆	ATTACHED	X FRE	E FLYER	□ 0TV	OPS	
1. \$	STATION A	TIVATION	(E.G., SET-U	P/ASSEMBLY	//ATTACHN	ENT AND	CHECKOUT)	
(DATE(S)	1998	INT. HRS_		EVA HRS	40	EVA CREW_	2
	_				, .			
	□ NOT A	PPLICABL	E					
2. 9	SERVICE (E	.G., REPLEI	NISH/RESUPI	PLY)				
1	NTERVAL	720 DA	YS TOT	AL SERVICE	s <u>2</u>			
	TMS/0	ITV REQUI	RED		ST	ATION HR	S PEI. JERVICE	8
	□ NOT A	PPLICABLE	<u> </u>		EV	A HRS PER	SERVICE _	
					EV	A CREW SI	ZE _	
3. \$	STATION O	PERATION	AL SUPPORT	(AVG. TIME	FOR MONI	TOR, I NS PE	CT, ETC.)	
		HRS PER DA	AY (INTERN	AL)				
		HRS PER DA	AY (EVA)			•	•	
	☑ NOT A	PPLICABLE	E				•	
4. [RECONFIGU	RATION						
ı	NTERVAL.	1095 DA	YS TO	TAL RECON	FIGS			
	☐ TMS/0	TV REQUII	RED		STA	ATION HRS	PER RECONFIG.	
	□ NOT A	PPLICABLE	•		EV	A HRS PER	RECONFIG	40
					EV	A CREW SIZ	ZE _	2
5. (DEACTIVAT	ION/REMO	VAL					
(DATE(S)		INT. HRS		EVA HRS_		_ EVA CREW	
					-			
	⊠ NOT A	PPLICABLE						
6. 1	NOTES (BRI	EFLY DESC	RIBE TASKS	IN 1 THROL	IGH 5 ABOV	/E)		
	1. Ref	ector v	vill be a	ssembled	l at sta	tion an	d then depl	oyed
		Free F) haa				
	2. 2 S	ervice i	rips @ &	s nours e	each - I	MS 1N S	itu service	?

GDC-ASP-83-002

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Code: GDCD 0001

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Large Deployable Reflector (LDR)

Reference Documents:

1. Science and Applications Requirements for Space Station NASA Hq., p.11, RCVD 11/17/82

- 2. Astrophysics Project Concept Document, GDC Document No. 10-004N, October 1980
- 3. NASA TM-82482, MSFC, April 82

Narrative:

The free-flying accommodation is from Ref 1.

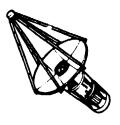
The launch date, duration, and crew-related requirements are derived. The weight for a 20-m reflector requiring man-assisted deployment is extrapolated from Ref 2, 12-meter reflector. Two shuttle launches are assumed.

It was assumed that the LDR is assembled in space station orbit by EVA. service is assumed to be compatible with TMS. Configuration change will be accomplished at the station by man (Ref 3) using EVA.

Remaining data based on Ref 1 and 2.

The LDR is envisioned as a complete spacecraft without self-propulsion.

From Ref 2.



266.592-402

Large Deployable Reflector

		Page 1 of
PAYLOAD ELEMENT NAME Far UV Spectroscopy Explorer	CODE 6 0 C 0 0 0 2	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division		Applications (non-commercial)
Hadross P.O. Box 85357 San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Technology Decelorant
STATUS		Operations
	ato unity	Type Number
First flight, yr 1989 No. of flights 1 Duration of Flight, days 1825		(see Table A) Importance of the Space Station to
and 1		this Element 1 - low unlum but could use 10 - vital
		Scale 1 - 10 4
DESCRIPTION		
The FUSE is being planned for a Shuttle launch and in, ction into GEO orbit.	and in ction into	GEO orbit.

ERISTICS 1-786 Perigee, km 35,786 Tolerance + 16g 28.5 Perigee, km 35,786 Tolerance + 16g 28.5 Perigee, km 35,786 Tolerance + 16g 28.5 Perigee, km 10g the Tolerance + 11 known) 12 Zooo	CODE 6.0.0.0.0.2 Page 2 of 3	ERISTICS 1,786 Parigeo, km 35,786 Tolerance + fog Ephemaris Acc	TATION	rating Power, naby 2000	NS ements! lealtime XOffline cryption Required ommand Rate (KBS) Processing Required	Types: Analog Digital (Amount) TO (Hrs/Day) Ard Storage (MBIT) Dump Frequency (Per Orbit)
--	------------------------------	--	--------	-------------------------	--	---

CODE 6 D C D 0 0 0 2 P 2 3
ive Passive Passive
i Remote ixed Unpressurized M H, M H, M H, M 1360
Task Assignment
Skills (Soo Table B) SKILL LEVEL Hrs/Dau
EUA CYES KNO Reason Hrazeua
Consumables
ONFIGURATION CHANGESIInterval, day Man/Hrs Req. Deliverables, kg Returnables, kg
. ions pacecraft provides apogee kick

GDCD CODE 0002 ELEMENT NAM	E FAR UV SPECTROSCOPY EXPLORER
ACCOMODATION: ATTACHED TO F	REE FLYER
1. STATION ACTIVATION (E.G., SET-UP/ASSEMB	LY/ATTACHMENT AND CHECKOUT)
DATE(S) INT. HRS	EVA HRS EVA CREW
NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	·
INTERVAL DAYS TOTAL SERVI	CES
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HAS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIN	IE FOR MONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
☑ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECO	NFIGS.
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) INT. HRS	EVA HRS EVA CREW
☑ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THR	OUGH 5 ABOVE)

- Launched by Shuttle/upper stage in 1989
 Spacecraft assumed to boost itself out of Geosynchronous orbit.

Code: GDCD 0002

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Far Ultraviolet Spectroscopy Explorer (FUSE)

Reference Documents:

- Science and Applications Requirements for Space Station NASA Hq., p.10, RCVD 11/17/82
- 2. Astrophysics Project Concept Document, GDC Document No. 10-004J, October 1980

Narrative:

The Far Ultraviolet Spectroscopy Explorer (FUSE) is assumed to be best accommodated in the free-flying mode as sugested in Ref 1, with station-attached accommodations based on acceptable contamination countermeasures and pointing.

The pointing accuracy objective, description, and special considerations are from Ref 1.

Mission duration, mass, data generation rate, orbit, and sketch are from Ref 2. Remaining data derived.

From Ref 2.

266.592-403

Far Ultraviolet Spectroscopy Explorer

1		Page 1 of 3
	CODE	
VY Long Baseline Interfer Demo	6 0 0 0 0 0 3	> \(\tau_{1}^{2} \)
CONTACT W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division		Applications (non-commercial)
San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Tachnology
STATUS Operational	P	Operations
	ate	Type Number
ght, yr 1995 ights 1 of Flight, days 1095		(see Table A) Importance of the Space Station to
OBJECTIVE To provide maps of compact celestial radio sources with finer resolution, less ambiguity, and more efficiency than earthbound VLB1 techniques.	p	this Element 1 = low value but could use 10 = vital
		2
DESCRIPTION The very long baseline interferometry mission requires correlation of measurements with the ground. The orbiting portion is placed by the Shuttle. Servicing can be performed from a station controlled TMS. Cohabitation with the station is a possibility if pointing and contamination requirements can be met.	equires correlation Shuttle. Servicing station is a possib	equires correlation of measurements with the Shuttle. Servicing can be performed from a station is a possibility if pointing and con-

CODE 6 0 0 0 0 0 3 Page 2 of 3	1gee, km 400 Tolerance + 4600 Tolerance + 0 = Ephemeris Accuracy, m	nertial Solar Earth Soc Solar Earth Sec 150 Field of view, deg Itter)arc sec/sec Solance Solan	Power, U Duration, hrs/day O Frequency, Hz	N Requir	malog Digital Hra/Day Uoice (Hrs/Day) Other Other W (Per Orbit) W SS 12,000 Downlink Frequency (MHZ)
	ORBIT CHARACTERISTICS Apogee, km 400 Inclination, deg 57 Nodal Angle, deg Escane dV Required.m/s	ENTATION on XInertial (if known) uracy, arc sec 150 billty (Jitter) arc	JAC Do Power, Operating 900 Power, Standby 1400	MUNICATIONS ng requirements: Realtime XOf uption/Decryption Require nk Req.: Command Rate (K) oard Data Processing Req	Data Types: Analog Digition (Hrs/Day) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 12,000

CODE 6 D C D O O 0 3
THERMAL [X]Active Passive Temperat 9, deg C operational min max Heat Rejection, w operational min max
L CHARACTERISTICS rnal
L,m 5 W,m 1.5 H,m 1.5 L,m W,m H,m 1.5 Consumables Types Cryogens
1 .
Skills (Soe Table B) SKILL LEVEL Hrs/Dau
EUA TYES XNO Reason Hrs/FUA
Consumables, kg 8 150 Man Hours Man/Hrs Req.
SPECIAL CONSIDERATIONS/See Instructions RFI Sensitive Contamination Pointing Stability Target View Time

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GC	CO CODE 0003 ELEMENT NAME VERY LONG BASELINF INTERFEROMETRY DEMO
AC	COMODATION: ATTACHED FREE FLYER OTV OPS
1.	STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)
	DATE(S) 1995 INT. HRS EVA HRS EVA CREW
	□ NOT APPLICABLE
2.	SERVICE (E.G., REPLENISH/RESUPPLY)
	INTERVAL 360 DAYS TOTAL SERVICES 2
	TMS/OTV REQUIRED ALTERNATE STATION HES PER SERVICE 8
	□ NOT APPLICABLE EVA HRS PER SERVICE
	EVA CREW SIZE
7	STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)
٠.	HRS PER DAY (INTERNAL)
	HRS PER DAY (EVA)
	■ NOT APPLICABLE
	MUI AFFEIDABLE
4.	RECONFIGURATION
	INTERVAL DAYS TOTAL RECONFIGS
	☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG
	■ NOT APPLICABLE EVA HRS PER RECONFIG.
	EVA CREW SIZE
5.	DEACTIVATION/REMOVAL
	DATE(S) 1998 INT. HRS EVA HRS EVA CREW
	□ NOT APPLICABLE
6.	NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)
	This payload element assumes accommodation on a platform or modified Leasecraft-type spacecraft which has orbit transfer propulsion.
	 2 servicings via TMS or equivalent Shuttle/TMS/OTV Retrieval

TOTAL EVA HRS _____

and a horse

Code: GDCD 0003

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Very Long Baseline Interferometry (VLBI) Demo

Reference Documents:

- Science and Applications Requirements for Space Station, NASA Hq., p. 11, RCVD 11/17/82
- Astrophysics Project Concepts Document, GDC Document No. 10-004Q, October 1980
- 3. Science and Applications Space Platform Payload Accommodations Study, SP82-MSFC-2583 p. A-25, March 1982
- 4. LANL Discussion, December 1982
- 5. Nominal Mission Model, Rev 6, MSFC PSO1, 9/30/82

Narrative:

The VLBI payload element is assumed to be best accommodated (due to size and pointing) as a free-flyer (Ref 5), although station-attached accommodation is also suggested Ref 1.

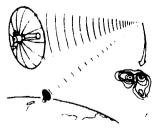
The weight is for instrumentation package and integration structure (pallet) and does not include propulsion system. A Leasecraft-type spacecraft could be added (modified for freon loop thermal control) to provide spacecraft resources and orbit transfer propulsion, platform accommodation.

The crew-related data and launch date are derived.

Remaining data based on Ref 1, 2, 3.

This payload element assumes accommodation on a platform or Leasecraft type spacecraft which has orbit transfer propulsion.

From Ref 2 for the Instrumentation Package.



266.592-404

Orbiting VLBI

	- 1		Page 1 of
PAYLOAD ELEMENT Space Telescope	EMENT NAME	CODE 6 D C D O O 0 4	
CONTACT Name Address	W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division		Applications (non-commercial)
	San Diego, CA 92138		Commercial
Telephone	(619) 277-8900, Ext. 3778/2130		Technology
STATUS Operatio		ned	Coperations
		JOpportunity	Type Number
First flight, yr No. of flights Duration of Fligh	ht, yr 1992 ghts 1 f Flight, days 1825		(see Table A) Importance of the Space Station to
OBJECTIVE To learn of t	DBJECTIVE To learn of the evolution of stars, of our and other qalaxies;		ب
and to explore quasar	e quasars, pulsars, gas clouds, and other planets.	and other planets.	1 = low calus but Could use 10 = vital
			Scale 1 - 10 4
DESCRIPTION			
The Space Telescope be available for ST : ment and replaced in periodic servicing.	(ST) will b servicing. η orbit for	or about 5 years befo be returned to earth TMS from then on.]	ST) will be in service for about 5 years before a station-based TMS will ervicing. The ST could be returned to earth for updating and refurbishorbit for service by the TMS from then on. The TMS could be used for
ST Space Stat	ST Space Station support operations are assum	assumed to begin in 1992.	

AND THE TANK I A TOTAL TO

m				, , , , , , , , , , , , , , , , , , ,	
GDC D O O O 4 Page 2 of	ORBIT CHARACTERISTICS Apogee, km 600 Ferigee, km 600 Tolerance + Inclination, deg 28.5 Tolerance + Nodel Angle, deg Ephemeris Accuracy, m Escape dV Regulred.m/s	OINTING/ 18w dire- ruth Sit- ointing ointing	c Dorating Lik	ints: time X Of ption Requir	Data Types: Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

CODE 6.0.0.0.0.4 Page 3.673
X SE WIE
Heat Rejection, w operational min max
ARACTERISTICS Remote
surables Types
1
LEUEL
EUA X YES UNO Reason Configuration Change Hrs/EUA 64
CONFIGURATION CHANGES: Interval, day 720 Many Hr. Por. 40
kgReturne
ONS
orbit. Bring to station for
2 assumed for configuration changes.

GDCD CODE 0004 ELEMENT NAME SF	PACE TELESCOPE
ACCOMODATION: ATTACHED THE FLY	ER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATT	ACHMENT AND CHECKOUT)
DATE(S) 1992 INT. HRS EVA	HRS EVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 720 DAYS TOTAL SERVICES 2	}
TMS/OTV REQUIRED	STATION HRS PER SERVICE 12
□ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR N	IONĪTOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	·
☑ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL 720 DAYS TOTAL RECONFIGS.	
TMS/OTV REQUIRED	STATION HRS PER RECONFIG. 8
☐ NOT APPLICABLE	EVA HRS PER RECONFIG. 32
	EVA CREW SIZE2
5. DEACTIVATION/REMOVAL	
DATE(S) 1997 INT. HRS EVA H	IRS EVA CREW
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	ABOVE)
1. Space Telescope launched in 198	
for Space Station support in 19 4. TMS retrieval with EVA for reco	
Shuttle/TMS Retrieval	-

Code: GDCD 0004

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Space Telescope (ST)

Reference Documents:

 Science and Applications Requirements for Space Station, NASA Hq., p. 10, RCVD 11/17/82

- 2. Nominal Mission Model, Rev 6, MSFC PSO1, 9/30/82
- 3. NASA TM-82482, MSFC, April 82
- 4. LANL Discussions, Dec 1982

Narrative:

The free-flying accommodation is from Ref 1. Launch date is from Ref 2 for space station supported operations. An additional service was added in 1996. Configuration change is assumed to be accomplished at the station by man (Ref 3) using EVA. The spacecraft has no propulsion system (Ref 1). The crew-related data are derived.

Remaining data based on Ref 1.

The ST would probably continue as a national facility beyond the year 2000.

- 1		Page 1 of 3
PAYLOAD ELEMENT NAME Shuttle IR Telescope Facility	CODE G D C D O O O 5	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division		(X) Science & Applications (non-commercial)
San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		- Tachnology
		Jova Lopaort
nal	ned	Operations
	Opportunity	
1990		(See Table A)
Duration of Flight, days 1825		Importance of the
		د د د د
To conduct definitive high-sensitivity infrared photometric and spectroscopic studies of a wide range of astrophysical phenomen	sensitivity infrared photometric and wide range of astrophysical phenomena.	1 - low onlue but
		10 - vital
		Scale 1 - 10 6
DESCRIPTION		
initially, the Shuttle infrared telescope facility (SIRTF) is to be a Shuttle mission. limits operation to 14 days. Attempts should be made to have SIRTF a station resident serviced as a free flyer by the station-based TMS.	ed telescope facility (SIRTF) is to be Attempts should be made to have SIRTF ne station-based TMS.	oe a Shuttle mission. This F a station resident, or
Assume reconfigured for Space Station operations beginning in 1990.	ions beginning in 1990	

CODE G D C D O O O S Fage 2 of 3	Tolerance + 0 Ephemeris Accuracy, m	☐Solar ☐Earth Field of view, deg sec/sec	U Duration, hrs/day	no (X)Other IDRSS Compatible Frequency (MHZ)	Digital Thra/Day Voice (Hrs/Day) Other Other
	ORBIT CHARACTERISTICS Apoges, km 400 Periges, km 400 Inclination, deg Nodal Angle, deg Escape dV Regulred, m/s	OINTING/ORIENTATION Item direction	rating 1300 Power, adby 2735	ng requirements; ng requirements; Resiting XOf yption/Decryption Requirent Requirent Requirent Requirent Refer (King Regulation Requirent Refer (King Regulation Referencessing Referencessing Regulation Referencessing Refer	Data Types: Analog Dig Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit)

CODE	C D 0 0 0 5
THERMAL [X] Active	
Ized Uppressurized Ixed Uppressurized M 4 H M M 7018 MS1tivitu a min	Stowed Deptoyed
0 A t	Operation
oe Table B) SKILL LEUEL	
Hrs/Day 0.5	
EUA IXIYES LINO Rouson Service Hrs/EUA	ZEUA 36
180 Cons	·
Interval, day	1 '
kg	Returnables, kg
ion contamination ts > 60 degrees from FOV Rad sensitivity	

Gl	GDCD CODE 0005 ELEMENT NAME SHUT	TLE IR TELESCOPE FAC	ILITY (SIRTF)
A	ACCOMODATION: 🛛 ATTACHED 🔲 FREE FLYI	ER* OTV OPS	
۱.	. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	CHMENT AND CHECKOUT)	
	DATE(S) 1990 INT. HRS EVA	HRS EVA CREW	/
	□ NOT APPLICABLE		
2.	2. SERVICE (E.G., REPLENISH/RESUPPLY)		
	INTERVAL 180 DAYS TOTAL SERVICES9		
	TMS/OTV REQUIRED	STATION HRS PER SERVICE	
	□ NOT APPLICABLE	EVA HRS PER SERVICE	4
		EVA CREW SIZE	
3.	3. STATION OPERATIONAL SUPPORT (AV.J. TIME FOR M	ONITOR, INSPECT, ETC.)	
	0.5 HRS PER DAY (INTERNAL)		
	HRS PER DAY (EVA)		
	□ NOT APPLICABLE		
4.	. RECONFIGURATION		
	INTERVAL DAYS TOTAL RECONFIGS.		
	☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIC	.
	■ NOT APPLICABLE	EVA HRS PER RECONFIG.	
		EVA CREW SIZE	
5	3. DEACTIVATION/REMOVAL		
٠.	DATE(S) 1995 INT. HRS EVA H	RS FVACREW	
	□ NOT APPLICABLE		
6.	3. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THAOUGH 5 A * Free Flyer accommodation is an al require re-evaluation of all requ	ternate mode, and if	used will
	 SIRTF launched in 1989. Reconfi in 1990. 	gured for station an	d attached
	 Replace consumables (helium) ev Instrument control and monitori 		
	5. Remove and repackage for earth		

Code: GDCD 0005

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Shuttle IR Telescope Facility (SIRTF)

Reference Documents:

 Science and Applications Requirements for Space Station, NASA Hq., p.11, RCVD 11/17/82

- Astrophysics Project Concept Document, GDC Document No. 10-004L, October 1980
- 3. LANL Discussions, December 1982

Narrative:

The SIRTF is assumed to be reconfigured for Station operations in 1990. The Station-attached accommodation mode was selected from among alternatives listed in Ref 1 and 2. The basis of this recommended mode is to reduce spacecraft or TMS cryogenic cooling service trips. Since the Shuttle-based SIRTF will have developed suitable countermeasures for contamination (restricted operations) it is assumed that the attached accommodation will be cost-effective.

The SIRTF will provide a pointing system (IPS), Ref 2. Length is estimated and includes IPS.

The crew will start and monitor operation, assisted by ground-based astronomers, Ref (2). The crew-related data and mission launch/duration data are derived.

Remaining data based on Ref 1 and 2.

1		Page 1 of 3
Gamma Ray Observatory	CODE 6 0 c 0 0 3 0	
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division Addross P.O. Box 85357		Applications (non-commercial)
San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Technology
STATUS Operational Operational Candidate	od da k	Operations
	Opportunity	Type Number
First flight, yr 1988 No. of flights Duration of Flight, days 1865		(See Table A) Importance of the
		5 + S
		could use 10 - vitel
		Scale 1 - 10 6
DESCRIPTION		
The Gamma Ray observation (GRO) originally designed to be a free flyer, could be serviced by a station-based TMS, or be a station resident.	signed to be a free 1	flyer, could be serviced by

m					
CODE G.D.O.O.3.0 Page 2 of 3	ORBIT CHARACTERISTICS Apogee, km 400 Tolerance + 50 - 50 Inclination, deg Tolerance + 28.5 - 50 Nodal Angle, deg Ephemeris Accuracy, m	OINTING/ORIENTA lew direction ruth Sites (if ointing accurac ointing Stabili	rating ndby k	MUNICATIONS ng requirements: \times	Data Types! Analog Digital Hra/Day Film (Amount) Live TU (!rs/Day) On-Board Storage (MB.T) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

X Passive ag C operational min non-operational min non-operational min	L CHARACTERISTICS Lion	CREU REQUIREMENTS Task Assignment Crew Size Skills (See Table B) Skill Hrs/Day Hrs/EUA SerVice SerVice Hrs/EUA SerVice SerVice Hrs/EUA SerVice SerVice Hrs/EUA Se	
S Pas C non-	EQUIPMENT PHYSICAL CHARACT Location: Internal X Equipment ID/Function L,m L,m L,m Consuma	CREU REQUIREMENTS Crew Size Skills (See Table B) EVEL Hrs/Di Augs SERVICING/MAINTENANCE SERVICE:Interval, days Returnables, kg Returnables, kg Returnables, kg Returnables, kg Returnables, kg Augustion and Deliverab SPECIAL CONSIDERATIONS/See Inst Naturally occuring radioactivity in matenumber should not be in proximity.	

GDCD CODE 0030 ELEMENT NAME GAM	MA RAY OBSERVATORY (GRO)
ACCOMODATION: ATTACHED THE FL	YER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATT	TACHMENT AND CHECKOUT)
DATE(S) INT. HRS EVA	A HRSEVA CREW
☑ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 365 DAYS TOTAL SERVICES 3	3
X TMS/OTV RECEMBER ALTERNATE	STATION HRS PER SERVICE8
NOT APPLICABLE	EVA HRS PER SERVICE 4
	EVA CREW SIZE 1
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR	MONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	• .
☑ NOT APPLICABLE	
4: RECONFIGURATION	
INTERVAL DAYS TOTAL RECONFIGS.	
☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
⊠ NOT APPLICABLE	EVA HRS PER RECONFIG.
<u> </u>	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	·
DATE(S)1993 INT. HRS EVA	HRS EVA CREW
C NOT ASSUES	
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 This payload element has orbit tra	
 Payload launched by shuttle in Three service trips, 1990, 139 	1988. 1, 1992 via TMS or equivalent and EVA

Code: GDCD 0030

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Gamma Ray Observatory (GRO)

Reference Documents:

- Science and Applications Requirements for Space Station, NASA Hq., p.11, RCVD 11/17/82
- 2. Nominal Mission Model, Rev 6, MSFC PSO1, 9/30/82
- 3. LANL Discussions, December 1982

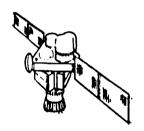
Narrative:

The GRO is designed and deployed in orbit in 1988 prior to the Space Station/TMS era. It is assumed that the TMS will have capability to retrieve the GRO for service at the station, or the GRO could return to the station using spacecraft propulsion. In either event, servicing at the station is assumed vs in-situ servicing due to potential incompatibility with TMS.

The launch date and weight are from Ref 2, and the mission duration is estimated. The crew-related data are derived.

Remaining data based on Ref 1.

Derived space-maintainable concept:



266.592-405

Gamma Ray Observatory

Code: GDCD 0031

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: High Throughput Mission (HTM)

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA Hq., p. 14, REVD 11/17/d2

Narrative:

Station-attached accomodation is assumed for the HTM. Crew-related requirements are derived.

Flight dates and duration are assumed; however, this payload element could continue operating after the year 2000.

The remaining data are based on Ref (1) which uses Large Area Modular Array (LAMAR) as representative requirements for HTM.

- 1		Page 1 of
PAYLOAD ELEMENT NAME High Throughout Mission	CODE	TYPE
agilbac 1313	1.5.0.0.0.3.1.	1 Sc. (8)
Mddross P.O. Box 85357 San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130	٠	Technology
nal	poul	Operations
	Opportunity	
First flight, yr 1999 No. of flights 1 Duration of Flight, days 1460 ORIECTINE		(see Table A) Importance of the Space Station to
ate high energy he very compact stars.		this Element 1 " low value but could use
		Scale 1 - 10 5
DESCRIPTION HTM is an X-ray telescope that obtains good resolution by trading off mirror quality for quantity. It is a good candidate for a Space Station resident facility, and could benefit from the station facilities and manual attention. Duration can continue beyond 2000.	resolution by trading e Station resident fac tion. Duration can co	tion by trading off mirror quality for ion resident facility, and could benefit Duration can continue beyond 2000.

.:

CODE 6 0 0 0 3 1 Page 2 of 3	ERISTICS 100 Perigeo, km 400 Tolerance + deg 28.5 Tolerance + deg Ephemeris Accuracy, m	NTA LL CL	Operating 2000 Power, W Duration, hrs/day Standby Peak	UNICATIONS grequirements; [X]Realtime XOf ption/Decryption Requir k Req.: Command Rate (K) ard Data Processing Rec	Data Types: Analog Digital Hrs/Day Film (Amount) Live iV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 125 Downlink Frequency (MHZ)
	ORBIT CHARACT Apoges, km / Inclination, Nodal Angle, Escane du Red	John Jrac Fruth Site Solnting S	POUER AC Oper Stan	ATA/COMMI Ton toring None MUPLINK MON-Boar	Fila Cica On-Boar

THERMAL	Page 3 of	m
Activa Passive		
non-operational ain		
Heat Rejection, w operational min max		
DUUCTON DUICE CONTROLL MIN		
THISTORY CHARACTERISTICS		γ—
ب		
	7	
E.X. 8'3	Stowed	
10,000 kg	D e fic:	
Types		
Acceleration		
IREMENTS		_
Crow Size Deration		
LEUEL 2		
Hrs/Day 1		
Service		
ALBYEON		
	•	
M-1/U-1		
blas, ka		
lons		
	-	

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GDCD CODE	0031	ELEMENT NAM	HIGH	THROUGHPUT	MISSION	
		TTACHED F				
1. STATION	ACTIVATION (E.G., SET-UP/ASSEM8	LY/ATTAC	HMENT AND CH	IECKOUT)	
DATE(S)	1999	INT. HRS	EVA HR	IS	_ EVA CREW_	
			_			
רסא 🗀	T APPLICABLE					
2. SERVICE	(E.G., REPLENI	SH/RESUPPLY)				
INTERVA	L 360 DAYS	TOTAL SERVI	CES3_			
☐ TM	S/OTV REQUIRE	0		STATION HRS P		
□ NO	T APPLICABLE			EVA HRS PER S		
				EVA CREW SIZE		1
3. STATION	OPERATIONAL	SUPPORT (AVG. TIM	AE FOR MOI	NITOR, INSPECT	r, etc.)	
1.0	_HRS PER DAY	'(INTERNAL)				
	HRS PER DAY	(EVA)				
□ NO1	T APPLICABLE					
4. RECONFI	GURATION					
		TOTAL RECO	ONFIGS.			
_	S/OTV REQUIRE		_	TATION HRS P	ER RECONFIG	i
⊠ NO7	T APPLICABLE			VA HRS PER RI		
			ε	EVA CREW SIZE	_	
5. DEACTIV	ATION/REMOV	AL				
DATE(S)	1	NT. HRS	_ EVA HRS	s	EVA CREW _	
			_		_	
Ø NO1	T APPLICABLE					
* Free	Flyer acc	IBE TASKS IN 1 THR commodation is luation of al	an alt	ernate mod	e, and if	used will
2. 3 3. Ir	Service EV	co station con /A's - replace control and mo iched beyond y	edet.g	as g	PS.	

TOTAL EVA HRS 36

ORIGINAL FACE IS OF POOR QUALITY

GDC-ASP-83-002

Page 1 of 1 Volume II, Book 1 Appendix I

Code: GDCD 0032

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Large Area Modular Array (LAMAR)

Reference Documents:

- Science and Applications Requirements for Space Station, NASA Hq., p. 14, RCVD 11/17/82
- 2. Astrophysics Project Concept Document, GDC Document No. 10-004E, October 1980
- 3. Science and Applications Space Platform Payload Accommodations Study SP82-MSFC-2583, p. A-51, March 1982
- 4. LANL Discussions, December 1982

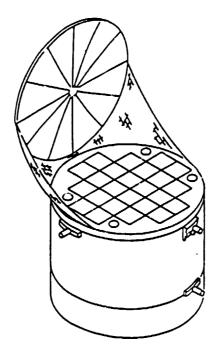
Narrative:

Station-attached accommodation is assumed for LAMAR. Launch weight is from Ref 3.

Crew-related requirements and service requirements are derived.

Remaining data based on Ref 1, 2, and 3.

From Ref 3.



266.592-406

	Page 1 of
PAYLOAD ELEMENT NAME CODE	TYPE
ea Modular Array	X Science &
W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division	
Addrass P.O. Box 85357 San Diego, CA 92138	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Tachnology
nal	Operations
Umpproved Ucandidate Opportunity	_
First flight, yr 1994 No. of flights 1 Deration of Flight, days 1640	importance of the Space Station to
i	ید
To conduct an all-sky survey of discrete X-ray sources and dif- fuse features with very high sensitivity and angular resolution.	1 - low value but could use 10 - vital
	Scale 1 - 10 8
DESCR:PTION LAMAR consists of 84 coaligned X-ray telescopes assembled in modular arrays. The mission makes an excellent station candidate because of the replenishment of expendable, and inherent	liar arrays. The mission of expendable, and inherent
maintenance required. Also, the manual operation enhances the capability of life span of the facility.	pability of life span of the

CODE 6.0 C.0 O 0.3 2 Page 2 of 3
Apogce, km 400 Perigee, km 400 Tolerance + Inclination, deg 28.5 Tolerance + Escape do Regulred.m/s
ENTA CATA CATA CATA CATA CATA CATA
6 2
UNICATIONS grequirements; XRealtime XOf ption/Decryption Requir k Req.: Command Rate (K) and Data Processing Rec
Data Types: Analog Digital Hre/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 125 Downlink Frequency (MHZ)

CODE	3.2 Page 3.5	r
THERMAL ———————————————————————————————————		?
S Remote ized X Lugarized 4.42 H, m	Stowed	
1 Task Assignment Operation	maxnn	
Skills (See Table B) SKILL 6 LEVEL 2		
EUA X VES UNO RANSON Service	64	
Consummbles,	-	
Man/Hrs Returns	Roq.	
	J	

G	3000 DCD	0032		ELEMEN.	NAME.	LARGE	AREA	MODU	LAR A	ARRAY	(LAMAR)
A	COMODAT	10N:	☑ ATTA	CHED	FREE	FLYER	· 0	0TV 01	PS		
1.	STATION .	ACTIVAT	ION (E.G.,	SET-UP/AS	SEMBLY	/ATTACH	MENT	AND CH	ECKOL	IT)	
	DATE(S)_	1994	INT. I	HRS		EVA HRS	S		EVA	CREW_	
	-								-	_	
	□ пот	APPLICA	RLE								
2.	SERVICE	(E.G., REF	LENISH/R	ESUPPLY)					•		
	INTERVA	ւ <u>360</u>	DAYS	TOTAL S	ERVICES	4					
	☐ TMS	VOTV RE	QUIRED		_	s	TATION	HRS P	ER SEF	IV:CE _	
	□ NOT	APPLICA	BLE _			E	VA HR	S PER S	ERVIC	E _	16
						ε	VA CRE	EW SIZE		_	1
3.	STATION	OPERATI	ONAL SUP	PORT (AV	G. TIME A	OR MON	ITOR, II	NSPECT	. ETC.)		
			R DAY (IN1				•				
			R DAY (EV								
	☐ NOT	- APPLICA	BLE								
4	RECONFIC	CHPATIO	u								
₹.			DAYS	TOTAL	RECONE	166					
	_	OTV REC						_	B REC	ONEIG	
		APPLICA									
	<u> </u>	AFFEIGA	OLE				/A CRE		CONT		
						•		** 5122			
5.	DEACTIVA	ATION/RE	MOVAL								
	DATE(S)_	1999	INT. H	IRS	f	VA HRS		F	VA CR	EW	
	-									_	
	U NOT	APPLICA	BLE								
6.		Flyer	escribe i accomm re re-e	odatio	n is a	n alte	rnate			ıd if	used
	2. 4 3. In	servic strume	nt to s e EVA's nt cont return	- rep	lace d d moni	et. ga toring	S				

		Page 1 of
PAYLOAD ELEMENT NAME Adv. X-Ray Astrophy Facility (AXAF)	CODE G D C D O 3 3	-
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division		Applications (non-commercial)
San Diego, CA 92138		- Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Technology
☐ ☐ Operational ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	date	Operations
	Opportunity	
First flight, yr 1991		-1
Duration of Flight, days 3600		Space Station to
OBJECTIVE		this Elomont
To extend previous results in X-ray astronomy research in the areas of source location and structure, spectroscopy, polarimetry, and temporal behavior	research in the roscopy, polari-	ں ر
merry, and temporal penavior.		io - vital
		Scale 1 - 10 4
SCRIPTION		
AXAF will be a Shuttle launched and maintainable national X-ray telescope facility with advanced capabilities in energy range, sensitivities, angular resolution, instrument complement, mission lifetime and target accessibility. It is designed for a 10 to 15 year life with update and servicing initially by the orbiter and becomes a prime candidate for station-based TMS update and servicing with major refurbishment taking place at the station rather than return to earth.	ible national X-ray to ivities, angular reso ty. It is designed biter and becomes a furbishment taking pla	e launched and maintainable national X-ray telescope facility with in energy range, sensitivities, angular resolution, instrument complene and target accessibility. It is designed for a 10 to 15 year life cing initially by the orbiter and becomes a prime candidate for stationservicing with major refurbishment taking place at the station rather

Apogee, km 500 Perigee, km 500 Tolerance + Inclination, deg 28.5 Nodal Angle, deg Ephements Accuracy, m Escape do Required.m/s
NG/ORIENT Traction Sites (if ng accura ng Stabil
☐AC Operating Standby Peak
MUNICATIONS ng requirements: Realtime Of Bption/Dacryption Requirent Requirent Requirent Requirent Refer (KI) oard Data Processing Requirent Reterment Refer (KI)
Data Types: Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

CODE CODE CODE
EQUIPMENT PHYSICAL CHARACTERISTICS Location External Romoto Equipment ID/Function Pressurized Unpressurized L,m L,m U,m H,m L,m L,m L,m L,m Launch mass, kg Cryogenics Consumables Types Acceleration sensitivitus of min Acceleration sensitivitus of min Consumables Consumables Consumab
Task Assignment
SKILL LEVEL
EUA XYES DNO Reason Configuration Change Hrs/EUA 128
Consummables,
day les, kg
Contamination sensitive. Designed to be serviced in orbit. Data dump rate 32 kbps. Iwo-man crew assumed for configuration change: skill 6, level 2; and skill 5, level 2.

man and a series of the series of the

GDCD CODE 0033 ELEMENT NAME AD	VANCED X-RAY ASTROPHYSICS FACILITY (AXAF)
ACCOMODATION: ATTACHED I FREE FL	YER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/AT	TACHMENT AND CHECKOUT)
DATE(S) 1991 INT. HRS EV	A HRS EV.A CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 720 DAYS TOTAL SERVICES	1
TMS/OTV REQUIRED	STATION HRS PER SERVICE8
□ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA U. EW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR	MONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
☑ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL 720 DAYS TOTAL RECONFIGS.	4
TMS/OTV REQUIRED	STATION HRS PER RECONFIG. 8
☐ NOT APPLICABLE	EVA HRS PER RECONFIG. 32
	EVA CREW SIZE 2
5. DEACTIVATION/REMOVAL	
DATE(S) INT. HRS. EVA	HRS EVA CREW
☑ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH S	ABOVE)

Code: GDCD 0033

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Advanced X-Ray Astrophysics Facility (AXAF)

Reference Documents:

- 1. Science and Applications Requirements for Space Station, NASA Hq., p. 14, RCVD 11/17/82
- 2. Nominal Mission Model, Rr 7, 'SFC PSO1, 9/30/82
- 3. NASA TM-82482, MSFC, April //
- Astrophysics Project Concept Document, GDC Document No. 10-004D, October 1980
- 5. LANL Discussions, December 1982

Narrative:

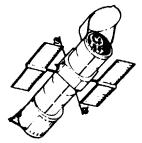
The free-flying accommodation is from Ref 1. The spacecraft does not contain orbit transfer propulsion system

Launch and schedule are from Ref (2) modified for constant 2-year service interval (versus 2- and 3-year service intervals).

Configuration change is assumed to be accomplished at the station by man (Ref 3) using EVA.

Remaining data based in Ref 1 and 4.

From Ref 4.



266.592-414

Advanced X-Ray Astrophysics Facility

	Page 1 of 3
PAYLOAD ELEMENT NAME High Resolution X & Y-Ray Spectrum	TYPE
JyJ. Peterson MZ 21-9530 Dynamics Convair Division	Applications (non-commercial)
Hadrass P.O. Box 85357 San Diego, CA 92138	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Tachnology Development
nal Planned	Operations
☐Approved ☐ Opportunity 7	
First flight, yr 1993 No. of flights 1 1080 In Duration of Flight, days 1080	Importance of the Space Station to
rgy resolution measurements of cosmic X-ray	his Element - low value but
and Gamma-Kay emission.	Could use
· ·	Scale 1 - 10 7
DESCRIPTION The high resolution X-ray and Gamma-Ray spectrometer facility has been examined from the point of view of a free flyer and as an attached mission on the station. All things bein normalized it would appear most feasible as a station attachment.	een examined from the tion. All things being

(C)	1 1 1 1				
GDE GD C D O O 3 4 Page 2 of		POINTING/ORIENTATION Usew direction	R Ac Operating Standby Peak	DATA/COMMUNICATIONS Monitoring requirements: XOffline XOther TDRSS Compatible None XRealtime XOffline XOther TDRSS Compatible None Encryption/Decryption Required Uplink Req.:Command Rate (KBS) XOn-Roard Data Processing Required Description	Data Types: Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 30 Downlink Frequency (MHZ)

•

3000	C D O O 3 4
ME TANGE TO A SECOND TO A SECO	O F oBel
PHYSICAL CHARACTERISTICS Internal External	
Lym 2.1	Stowed
& Solid	
Tack One in the	Y0E
oo Tablo B) SKILL	
Hrs/Day 0.5	
UNO Rouson Service	09
ANCE 180 Consumables.	
Da, kg	11
Deliverables, kd	s Roq.
lons	1
Proximity of natural radioactivity and materials with high atomic number is undesirable.	is undesirable.

GDCD CODE 0034 ELEMENT NAME HI	RESOLUTION X-RAY & GAMMA RAY SPECTROMETER
ACCOMODATION: ATTACHED - FREE FLY	YER* OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATT	ACHMENT AND CHECKOUT)
DATE(S) 1993 INT. HRS EVA	HRSEVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 180 DAYS TOTAL SERVICES	5
TMS/OTV REQUIRED	STATION HRS PER SERVICE
□ NOT APPLICABLE	EVA HRS PER SERVICE 12
	EVA CREW SIZE 1
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR	MONITOR, INSPECT, ETC.)
C.5 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	•
☐ NOT APPLICABLE	•
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONFIGS.	
☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
■ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	•
DATE(S) 1996 INT. HRS EVA	HRSEVA CREW
□ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 *Free Flyer accommodation is an alte	
require re-evaluation of all requir	
 Attached to station. Considered Service @ 6 mo replace gas 	station OPS
3. Instrument control and monitoria	
5. Removal and return to Earth-Stat	ion OPS

Page 1 of 1 Volume II, Cook 1 Appendix I

Code: GDCD 0034

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: High Resolution X-Ray and Gamma-Ray Spectrometer (HRS)

Reference Documents:

 Science and Applications Requirements for Space Station, NASA Hq., p. 14, RCVD 11/17/82

- 2. Science and Applications Space Platform Payload Accommodations Study, SP-82-MSFC-2583, p. A-50, March 1982
- 3. LANL Discussions, December 1982

Narrative:

From among the options listed in Ref 1, the HRS is assumed to be best accommodated in a station-attached mode.

The crew-related data and launch/mission data are derived.

The remaining data are based on Ref 1 and 2. Dimensions include an estimate for the pointing mount.

		Page 1 of 3
PAYLOAD ELEMENT NAME High Energy Isotope Experiment (HEIE)	CODE 6 D C D O 0 3 5	
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division		Applications (non-commercial)
Addross P.O. Box 85357 San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Technology Development
STATUS Operational Planned OApproved X Candidate	od de to	Operations
	Opportunity	Number
First flight, yr 1997 No. of flights 1 Duration of Flight, days 1100 OBJECTIVE		(see Table A) Importance of the Space Station to this Element
To search for rare nuclei and exotic particles like magnetic monopoles and to measure the composition of ultra-heavy nuclei.	. .	1 - low value but Could use 10 - vital
		Scala 1 - 10 4
DESCRIPTION If the HEIE is selected as a free-flyer, it will be placed in a 57 degree (or higher) orbit by the Shuttle, and periodically (about 6-month intervals) servicing will be required and could be handled from a station orbiting at the same inclination. Cosmic ray investigations have the least restrictive pointing and contamination requirements of any astrophysics discipline and should be easily accommodated in an attached mode.	vill be placed in a 57 intervals) servicing he inclination. Cosmicion requirements of a ched mode.	ted as a free-flyer, it will be placed in a 57 degree (or higher) orbit by riodically (about 6-month intervals) servicing will be required and could tation orbiting at the same inclination. Cosmic ray investigations have be pointing and contamination requirements of any astrophysics discipline accommodated in an attached mode.

•

C C		1			, , , , , , , , , , , , , , , , , , ,
CODE 6.0.0.0.3.5 Page 2 of 3	ORBIT CHARACTERISTICS Apogee, km 400 Ferigee, km 400 Tolerance + 35 30 Inclination, deg 57 Nodel Angle, deg Ephemeris Accuracy, m Ephemeris Accuracy, m	OINTING/ORIENTA low direction ruth Sites (if ointing accurac ointing Stabili	rating indby ik	rements: Teasitime 00f scryption Requir Command Rate (K)	Data Types: Analog Digital Hra/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Par Orbit) Recording Rate (KBPS)

CODE 6.0.0.0.3 5	
cive X Passive e, deg C operational min max tion, w operational min max non-operational min max max	
kg Types	
CREU REQUIREMENTS	
Craw Size 1 Task Assignment Operations	
9	
EUA [3 VES NO Reason Service	T
Consumables	
Man Hours Man/Hrs Rog.	
SPECIAL CONSIDERATIONS/See Instructions	
Orientation = Anti-earth. Inclination greater than 57 degrees acceptable.	
	7

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GDCD CODE 0035	ELEMENT NAME H	IGH ENERGY	ISOTOPE EXPER	IMENT	(HEIE)
ACCOMODATION: X ATTA	CHED	FLYER * 🔲 (TV OPS		
1. STATION ACTIVATION (E.G.,	SET-UP/ASSEMBLY/	ATTACHMENT AI	ND CHECKOUT)		
DATE(S) 1997 INT.	HRS 6	VA HRS	EVA CREW		
NOT APPLICABLE			-		
2. SERVICE (E.G., REPLENISH/F	RESUPPLY)				
INTERVAL 180 DAYS	TOTAL SERVICES	5			
TMS/OTV REQUIRED_		STATION	HRS PER SERVICE		
□ NOT APPLICABLE _		EVA HRS	PER SERVICE	8	
		EVA CRE	N SIZE	1	
O.5 HRS PER DAY (IN HRS PER DAY (EX DAY APPLICABLE 4. RECONFIGURATION INTERVAL DAYS	/A}				
TMS/OTV REQUIRED			IRS PER RECONFIC		
⊠ NOT APPLICABLE		EVA HRS F	PER RECONFIG.		
5. DEACTIVATION/REMOVAL					
DATE(S) 2000 INT.	HRS g	/A HRS	EVA CREW _		
☐ NOT APPLICABLE					
6. NOTES (BRIEFLY DESCRIBE *Free Flyer accommod require re-evaluati	ation is an al	ternate mo	de, and if u	sed wi	11

1 & 5 are considered as station OPS

Page 1 of 1 Volume II, Book 1 Appendix I

Code: GDCD 0035

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: High Energy Isotope Experiment (HEIE)

Reference Documents:

 Science and Applications Requirements for Space Station, NASA Hq., p. 17, RCVD 11/17/82

Narrative:

The attached accommodation mode is assumed for HEIE as suggested by Ref (1).

The orbit of 57 degrees (or greater) is from Ref 1.

Remaining data derived.

	Page 1 of 3
PAYLOAD ELEMENT NAME Spectra of Cosmic Ray Nuclei (SCRN)	TVPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division	Applications (non-commercial)
	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	- Technology Development
STATUS	Operations
	Type Number
First flight, yr 1996 No. of flights 1 Duration of Flight, days 365	Importance of the Space Station to
	this Elomont
To help explain the characteristics and distributions of galactic cosmic-ray sources and the mechanism of cosmic-ray propagation through interstellar space.	1 - low value but could use 10 - vital
	Scale 1 - 10 8
DESCRIPTION Although SCRN was conceived to be used at an inclination of 57 degrees, attaching ic to the manned station provides sufficient over-riding benefits to stay on the station and operate at 28.5 degrees contamination and pointing should be easily satisfied. The flight duration could be made variable, dependent on data gathered rather than expendable depletion.	legrees, attaching ic to the on the station and operate sfied. The flight duration expendable depletion.

6					
C(1) E C D O O 3 6 Page 2 of 3	STICS Perigae, km 400 Tylerance + 35 30 Folerance + 0 28.5 Ephemeris Accuracy, m		.1	⊠of Requir Rate (Kl	Chalog Digital Hrs/Day t) s/Day) orage (MBIT) requency (Per Orbit) ate (KBPS) 102 Downlink Frequency (MHZ)
	133 1 3	POINTING/ORIENTAT Ulew direction Truth Sites (1f. k Pointing accuracy Pointing Stabilit	.1	UNICATION Braquin btion/De Req. 10 And Data	Data Types! Film (Amount) Live TU (Hrs/) On-Board Story Data Dump Free

4

	CODE G D C D O O 3 6
	L. 10 C 0 D 0 1
-	FBX
1 1 1	Xaz
EQUIPMENT PHYSICAL CHARACTERISTICS Location: Internal Remote Equipment ID/Function PressurizedX Innersancia	Xee
3.28 U, m 4.78 H, 3.28 H,	3.78 Stowed 3.78 Deployed
	Ereon
1	mox
Craw Size Task Assignment	Operation/Maintenance
•	
LEVEL	
Hrs/Day 0.2	
Service	Hra/FUA 8
Consumples,	kg 。
day man Hours	Mas/Hrs Res
bles, kg	_
lons	1
Earth pointing required for calibration.	
סוומנוסו - אונו-פמינו.	

GDCD CODE 0036 ELEMENT NAME	SPECTRA OF COSMIC RAY NUC	LEI
ACCOMODATION: ATTACHED - FREE	FLYER * TOTV OPS	
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/	ATTACHMENT AND CHECKOUT)	
DATE(S) 1995 INT. HRS	EVA HRS EVA CREW _	
NOT APPLICABLE		
2. SERVICE (E.G., REPLENISH/RESUPP: Y)		
INTERVAL 180 DAYS TOTAL SERVICES	1	
TMS/OTV REQUIRED	STATION HRS PER SERVICE _	
□ NOT AFPLICABLE	EVA HRS PER SERVICE _	8
	EVA CREW SIZE	1
3. STATION OPERATIONAL SUPPORT (AVG. TIME F	FOR MONITOR INSPECT, ETC.)	
0.2 HRS PER DAY (INTERNAL		
HRS PER DAY (EVA)		
□ NOT APPLICABLE		
	·	
4. RECONFIGURATION		
INTERVAL DAYS TOTAL RECONF	1GS	
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.	
☑ NOT APPLICABLE	EVA HRS PER RECONFIG	
	EVA CREW SIZE	
5. DEACTIVATION/REMOVAL		
DATE(S) 1998 INT. HRS	EVA HRS EVA CREW	
☐ NOT APPLICABLE		
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH *Free Flyer accommodation is an a require re-evaluation of all req	Iternate mode, and if use	d will
 Attached to station. Conside Replace Ne, CO2, FREON Instrument control and monito Removal/return considered sta 	ring	

Page 1 of 1 Volume II, Book 1 Appendix I

Code: GDCD 0036

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Spectra of Cosmic Ray Nuclei (SCRN)

Reference Documents:

 Sciexce and Applications Requirements for Space Station, NASA Hq., p. 17, RCVD 11/17/82

2. Science and Applications Space Platform Accommodation Study SP82-MSFC-2583, p A-37, March 1982

Narrative:

SCRN is assumed to be accommodated in the station-attached mode, continuing the present short-duration space lab accommodation.

The launch mission data orientation and crew related data are derived.

Remaining data based on Ref 1 and 2.

NAME In & Ion Cal		Page 1 of 3
Peterson MZ 21-9530 CA 92138 CA 92138 CA 92138 CA 92138 CA 92138 CAndidate Commercia Example of commercia Commer	RAME 6 D	TVPE
Commercial Commercia	ACT W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division	
Develop Deportunity (Scandidate Deportunity Candidate Deportunity Candidate Type Number Capportunity Capportunity Capportance Deportunity Capportance Deportunity and helium nuclei to determine This Element Deportunity and helium nuclei to determine This Element Deportunity and Low value of the County of Capportunity Deportunity	P.O. Box 89 San Diego,	Commercial
Planned Type Number 1996 Type Number 1996 1 1996 1 1996 1 1996 1 1996 1 1996 1 1996 1 1996 1 1996 1 1996 1 1996 1 1996 1 1996 1 1996 1 1996 1 1996 1 1996 1 1996 1 1996 19	(619) 277-8900, Ext.	O Technology Development
Example 1996 1 Opportunity 1996 1 days 200 1 mportance Static this Element is an outgrowth cervation times improve its capability by a factor of ten. a station resident experiment, since pointing accuracy and included and included its capability and included its capability and included its capability and included its capability by a factor of ten. a station resident experiment, since pointing accuracy and included its capability by a factor of ten.	Operational	Operations
protuns, and helium nuclei to determine this Elemen could under in the composition of cosmic-rays. Scale 1 - 10 outstance of ten. a station resident experiment; since pointing accuracy and resident experiment, since pointing accuracy and resident experiment.		Number
protcus, and helium nuclei to determine hange in the composition of cosmic-rays. 10 - vital Could u. 10 - vital Scale 1 - 1 Scale 1 - 1 ervation times improve its capability by a factor of ten. a station resident experiment, since pointing accuracy and "S."	1996 1 1, days 70	, , ,
major change in the composition of cosmic-rays. I		this Elomont
Scale 1 - 10 n radiation and ionization calorimeter experiment is an outgrowth of ten. ate for a station resident experiment, since pointing accuracy and ry factors.	<u>-</u>	100
n radiation and ionization calorimeter experiment is an outgrowth c Long observation times improve its capability by a factor of ten. ate for a station resident experiment, since pointing accuracy and ry factors.		
ervation times improve its capability by a factor of ten. a station resident experiment, since pointing accuracy and rs.	DESCRIPTION The transition radiation and ionization calorimeter exper	ment is an outgrowth of a Spacelab
	experiment. Long observation times improve its capability a good candidate for a station resident experiment, since are not primary factors.	<pre>/ by a factor of ten. It would make pointing accuracy and contamination</pre>

of 3			4 7		
Page 2 of 3	30		□ Continuous		
			°3 🗆	rible (MHZ)	
6.0 c.0 0 3.7	35 0		111	TDRSS Compatible Froquency (MHZ)	MHZ /MHZ
CODE	ance 4	irth View, deg	hep/s.	TDRS:	Dan
	Tolerance + Ephemeris Accuracy,		Duration, hrs/day	her	Voice (Hrs/Day) Other Downlink Frequency (MHZ)
	Toler	Field	Durat!	Other	Voice Down Li
	400	Solar Sec/sec	U Durat	Offline lutred (KBS) Required	امادوات المادوات
	ka	3600	Powers	Quin quin (Ki Rec	Analog Dil
	CS Perigee, km 57	TION Inertial	DC Pc	Sments! emitima ryption Re ommand Rate	Analog Day rage (MBIT) aquency (Pe
	5T1		ol ji	IONS Irements: Realtime Decryption Command R	t) s/Day) orage requen
	CHARACTERIS , km 400 ation, deg Angle, deg dU Reguire	POINTING/ORIENTA Ulaw diraction Truth Sites (if Pointing accurac Pointing Stabili Special Restrict	eting dby	DATA/COMMUNICATIO Monitoring requir None Encryption/Decorptink Req.:C XOn-Board Data Description	STA
	0 < 0	JOINTING/ Jiew directives Situating a Subting a	Oper Stan	Locami Locan None Encry Uplink On-Boe	Data Type Film (Amo Live TU (On-Board Data Dump
	ORBIT Apogeo Inclin Nodel	POINTI Ulew d Truth Pointi Secte	POUER O		

	CODE 6 D C D O O 3 7
THERMAL The Active X Passive Temperature, deg C operational min non-operational min Heat Rejection, w operational min non-operational min	
7 5 5 F	
mass, kg ibles Types atlon sensitivity,	X G M
	Operation,
SKILL B) SKILL IFUF!	
0 ha	
9	Hrs/EUA 9
Cons	ſ
Interval, day	VHrs Roq.
SPECIAL CONSIDERATIONS/See Instructions	Returnables, kg
Orientation = Anti-earth.	

GDC	O CODE	0037		ELEM	ENT NAME	TRANSIT	ION RAI	NOTATION &	ION	<u>CALORI</u> METER	(TRIC)
,cc	AGOMO	TION:	€ ATT	ACHED	☐ FR	EE FLYER*	_ on	V OPS			
1. S	TATION	ACTIVAT	ION (E.G.	. SET-UP	/ASSEMBI	Y/ATTACHI	MENT AND	CHECKOUT)			
D	ATE(S)	1996	INT.	. HRS		_ EVA HRS	 .	EVA CRE	:w		
	□ NO	T APPLICA	ABLE	_		-			<u></u>		
2. S	ERVICE	(E.G., RE	PLENISH/	RESUPP	LY)						
11	NTERVA	180	DAYS	TOTA	AL SERVIC	es <u>3</u>	_				
		S/OTV RE	QUIRED_			\$1	ATION HE	IS PER SERVI	CE		
	□ NO	T APPLICA	ABLE _			E	/A HRS PE	R SERVICE		3	
						E,	/A CREW S	SIZE		1	
4. R	0.5	HRS PE HRS PE T APPLICA IGURATIO AL S/OTV RE	R DAY (IF R DAY (F ABLE IN DAYS QUIRED	ITERNA VA)	iL)		ATION HR	S PER RECOŅ			
	⊠ NO	T APPLICA	ABLE				A HRS PER A CREW SI	R RECONFIG.			
		ATION/R		HRS				EVA CREW			
	□ NO	T APPLICA	ABLE								
*F	ree F	lyer ad	commod	lation	is an	uGH 5 ABO alterna quireme	te mode	, and if	used	will	
1.	Att	ached 1	to stat	ion.	Consid	lered st	ation O	PS			
3. 5.	Ins Rem	trument oval/re	t contr eturn c	roi an consid	d monit ered st	oring ation O	PS				

GDC -ASP-83-002

Page 1 of 1 Volume II, Book 1 Appendix I

Code: GDCD 0037

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Transition Radiation and ION Calorimeter (TRIC)

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA Hq., p. 17, RCVD 11/17/82

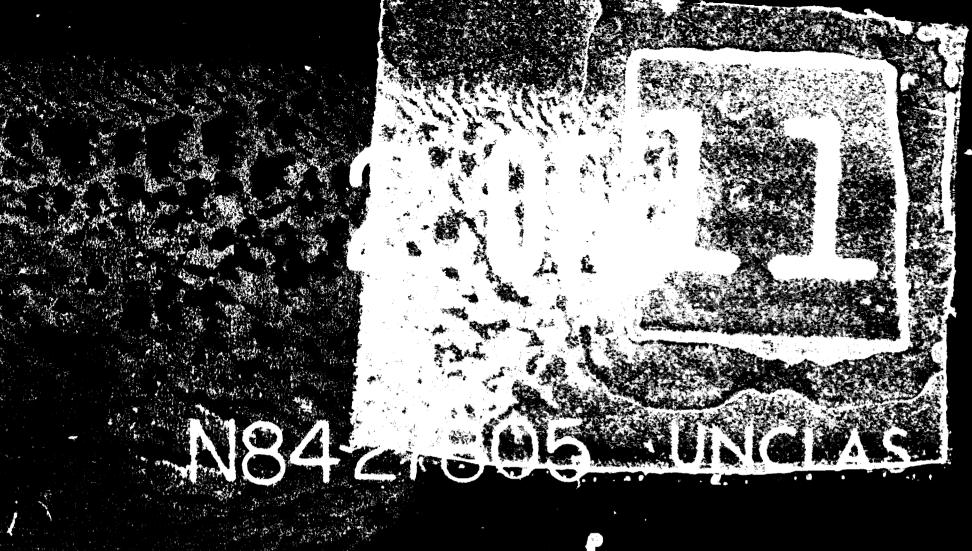
Narrative:

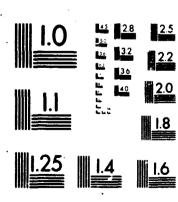
TRIC is assumed to be accommodated in the space station attached mode based on an extension of spacelab experiment with more stringent requirements.

The power and weight data, as well as mission objectives and description, are from Ref 1.

Remaining data derived. An anti-earth orientation was selected for instrument pointing.

AME		
X-Ray Timing Explorer (XTE)	CODE 0 0 3 8	TYPE X Science &
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division Addross P.O. Box 85357 San Diego, CA 92138		Applications (non-commercial)
Telephone (619) 277-3900, Ext. 3778/2130		Tachnology Developmen.
STATUS Operational XPlanned Approved Opportunity	<u>ئ</u> در 10 م	Operations Type Number
First flight, yr 1990 No. of flights 1 Duration of Flight, days 720 OBJECTIVE		Importance of the Space Station to this Element
To study the temporal variability in X-ray emitting objects.	ng objects.	1 - low value but could use 10 - vital
		Scale 1 - 10 7
DESCRIPTION The XTE is currently planned as a Shuttle-launched free flyer.	ed free flyer.	





MICROCOPY RESOLUTION TEST CHART NATIONAL BUREAU OF STANDARDS STANDARD REFERENCE MATERIAL 1010a (ANSI and ISO TEST CHART No. 2) OTTOTAL COLOR OF TO OF PORTAL COLOR OF THE

CODE G.D.O.O.3.8 Page 2 of 3	gee, km 400 lination, deg al Angle, deg ape do Require		Pointing accuracy, arc sec Field of view, deg	OUER Ac Dower, W Duration, hrs/day	Standby 3 Continuous Peak Voltage, V Frequency, Hz	MUNICATIONS ng requirements: \times \times \times 0.0 f \times \times \times 0.0 f nk Req.: Command Rate (K) oard Data Processing Requirents	Data Types: Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 10 Downlink Frequency (MHZ)
------------------------------	---	--	---	------------------------------------	--	---	--

(-2

	6.0.c.0.0.0.3.8 Page 3 of 3
THERMAL Garative Sperational min max non-operational min max Heat Rejection, w operational min max non-operational min max	
Ized Unpressurize	Stowed
Task Assignment	
la (See Table B) SKILL LEUEL	
EUA CYES XNO ROBSON Hrs/EUA	
SERVICING/MAINTENANCE SERVICE:Interval, days Returnables, kg	-
Interval, day	s Req.

GDCD COOE 0038	ELEMENT NAM	E X-RAY TIM	ING EXPLORER	
ACCOMODATION:	ACHED X F	REE FLYER (OTV OPS	
1. STATION ACTIVATION (E.G.	., SET-UP/ASSEMB	LY/ATTACHMEN	T AND CHECKOUT)	
DATE(S) 1990 INT	*. HRS	EVA HRS	EVA CRE	w
□ NOT APPLICABLE				
2. SERVICE (E.G., REPLENISH/	RESUPPLY)			
INTERVAL DAYS	TOTAL SERVI	CES		
TMS/OTV REQUIRED		STATI	ON HRS PER SERVIC	;E
■ NOT APPLICABLE		EVA H	IRS PER SERVICE	
		EVA 0	REW SIZE	
3. STATION OPERATIONAL SU	JPPORT (AVG. TIM	E FOR MONITOR	, INSPECT, ETC.)	
HRS PER DAY (II	NTERNAL)			
HRS PER DAY (E	EVA) .			
■ NOT APPLICABLE				
4. RECONFIGURATION				
INTERVAL DAYS	TOTAL RECO	NFIGS.		
TMS/OTV REQUIRED			ON HRS PER RECONI	FIG
■ NOT APPLICABLE		EVA H	RS PER RECONFIG.	
		EVA C	REW SIZE	
5. DEACTIVATION/REMOVAL				
DATE(S) 1992 INT.	. HRS	EVA HRS	EVA CREW	
—————————————————————————————————————	-		-,	
	- TACKE IN 1 TIAG	OUCUE ABOVEL		
6. NCTES (BRIEFLY DESCRIBE This payload element			ropulsion.	
2. No scheduled se 5. Shuttle/TMS rem	ervice. Sta	tion is ava turn to Ear	ilable for em	ergency service

Code: GDCD 0038

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: X-Ray Timing Explorer (XTE)

Reference Documents:

- Space Station NAAO Study Orientation Meeting, NASA Hq., 14-15 September 1982
- 2. Astrophysics Project Concept Document, GDC Document No. 10-004C-2, October 1980
- 3. LANL Discussions, December 1982

Narrative:

The XTE is a shuttle launched, free-flying payload element per Ref 2.

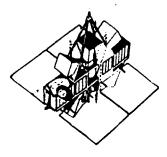
The spacecraft is designed with an on-board propulsion system, using hydrazine.

The mission duration, orbit, pointing accuracy, power, weight and TDRSS requirements are from Ref 2.

Remaining data derived.

Initial launch shown as 1988 in Ref 1; however, an additional launch is assumed in the 1990 decade.

From Ref 2.



266.592-407

X-Ray Timing Explorer

	Page 1 of 3
PAYLOAD ELEMENT NAME Solar Internal Dynamics Mission (SIDM) 6 0 C 0 0 0 6 0	3::1
	Clains and long
Maardss P.O. Anx 85357 San Diego, CA 92138	[] Consercial
Telephone (619) 277-8900, Ext. 3778/2130	[] Tache of ogg
STATUS Operational Operational X Candidate	Cloperations
	Tubo (umber
First flight, yr 1991 No. of flights 1 Duration of Flight, days 360	0 00000
OBJECTIVE To obtain data about the internal structure and dynamics of	CAIS STREAM
the sun.	18350 × 8
	Scale 1 - 10 2
DESCRIPTION	
The orbit requirements of the SIDM suggests a free flyer with possible service controlled by the Space Station.	ssible service controlled by

G D C D O O G O Page 2 of 3	Accuracy, m	□Earth ld of view, deg	ation, hrs/day	Other TDRSS Compatible Frequency (MHZ)	Other Day Other Day Other Day Other Other Day Other Day (MHZ)
	# A21	OINTING/ORIENTATION Lew direction Inertial Solar Earth ruth Sites (If known) ointing accuracy, arc sec Field of view, ointing Stability (Jitter)arc sec/sec necial Restrictions (Avoidance)	Duration, hrs/day 200 Frequency, Hz	ther	Data Types: Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 650 Downlink Frequency (MHZ)

CODE 6 B	090000
THERMAL []Active	
ized Unpressurize in Hemote Stowed Deployed	
Task Assignment	
ls (See Table B) SKILL LEVEL HEVEL Hrs/Da	
n .	Hrazeua
Consumables	
, day	Man/Hrs Rog. Returnab!es, kg
lons	j

GDCD	CODE	0060	SLEI	MENT NAME	SOLAR	INTERNAL	<u>DYNAMICS</u>	MISSION	<u>(</u> SIDM)
ACCO	MODATION:		ATTACHED	⊠ FR€	E FLYER	OT	V OPS		
							CHECKOUT)		
DA	ATE(S) 1991		INT. HRS_		_ EVA HE	ıs	EVA CREV	v	
	☐ NOT APP	LICABLE	-		-				
2. SE	RVICE (E.G.,	REPLEN	ISH/RESUP	PLY)					
iN	TERVAL	DAY	S TOT						
	TMS/OTV	REQUIR	ED			STATION H	RS PER SERVIC	E	
	NOT APP	LICABLE				EVA HRS PE	RSERVICE		_
						EVA CREW	SIZE		
3. ST	ATION OPER	RATIONA	L SUPPORT	(AVG. TIME	FOR MO	NITOR, INSP	ECT, ETC.)		
	на	S PER DA	Y (INTERN	AL)					
	HR	S PER DA	Y (EVA)						
	🗵 NOT APP	LICABLE							
4. RE	CONFIGURA	ATION							
IN	TERVAL	DAY	s to	TAL RECON	FIGS				
ı	TMS/GTV	REQUIR	ED		\$	TATION HR	S PER RECONF	IG	
-	🗵 NOT APP	LICABLE				VA HRS PE	R RECONFIG.		-
					ŧ	VA CREWS	IZE		_
	EACTIVATIO				EVA HR	3	EVA CREW		
	-		-						
	□ NOT APP	LICABLE							
6. NC	TES (BRIEF his paylo	LY DESC	RIBE TASKS ement ha	iniThro	UGH 5 A8 transi	ove) fer prop	ulsion.		
1. 5.			oit by s shuttle,	shuttle o	or ELV				

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Code: GDCD 0060

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Solar Internal Dynamics Mission (SIDM)

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA Hq., p. 19, RCVD 11/17/82

2. Nominal Mission Model, Rev 6, MSFC PSO1, 9/30/82

Narrative:

SIDM requires a sun-synchronous orbit (Ref 1). A free-flyer accommodation was assumed based on Ref 2.

The spacecraft weight is from Ref 2 and assumes orbit transfer provided propulsion.

The pointing, power, thermal control data generation rate, and service interval are from the typical characteristics shown in Ref 1.

Remaining data derived.

	Page 1 of 3
Solar Corona D'agnostics Mission (SCDM) 6 0 C 0 0 0 6 1	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division	Applications (non-commercial)
San Diego, CA 92138	Commercial
Telephone (6:9) 277-8900, Ext. 3778/2130	O Technology Develonment
STATUS	Operations
- Approved - Candidate - Opportunity	Type Number
e the cause of solar corona heating.	1 - low value but could use
	Scale 1 - 10 7
DESCRIPTION The SCDM has been envisioned as a possible free flyer. The SCDM s station resident experiment operated and maintained by the station	The SCDM should be studied as 1 the station personnel.

Tolerance + Temple Accuracy, m	□Earth sld of view, deg	Duration, hrs/day □continuous	X)Other TDRSS Compatible Frequency (MHZ)	Voice (Hrs/Day) Other Downlink Frequency (MHZ)
Apogee, km 400 Perigee, km 400 Tolera Inclination, deg 28.5 Tolera Tolera Ferige + Model Angle, deg Ephemeris Access	ENTATION On Inertial Solar Es (If known) uracy, arc sec 2 bility (Jitter) arc sec/sec rictions (Avoidance)	Doc Power, U	ther	Data Types: Analog Digital Hrs/Di Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 650 Downlink Freq

	6.0 C.0.0.0.6.1 Page 3 of 3
THERMAL Active X Passive Temperature, deg C operational min max non-operational min max Keat Rejection, w operational min max	
S Remoti	Stowed
REQUIREMENTS The base of the b	
Skills (See Table B) SKILL LEVEL	
FUA TVFC XINO Remson	UA
ICING/MAINTENANCE JICEIInterval, days Returnables, kg IGURATION CHANGES:Interval, day Deliverables, kg	kg

Motume II, Book 1 Appen ik i

GŪ	CD CODE 0061 ELEMEN	T NAME SOLAR CORONA DIAGNOSTICS MISSION (SCOM)
AC	COMODATION: ATTACHED	☑ FREE FLYER ☐ OTV OPS
1.	STATION ACTIVATION (E.G., SET-UP/A	SSEMBLY/ATTACHMENT AND CHECKOUT)
	DATE(S) 1993 INT. HRS	EVA HRS EVA CREW
	51 NOT ABBLICABLE	
	☐ NOT APPLICABLE	
2.	SERVICE (E.G., REPLENISH/RESUPPLY)
	INTERVAL DAYS TOTAL	SERVICES
	TMS/OTV REQUIRED	STATION HRS PER SERVICE
	NOT APPLICABLE	EVA HRS PER SERVICE
		EVA CREW SIZE
3.	STATION OPERATIONAL SUPPORT (A)	G. TIME FOR MONITOR, INSPECT, ETC.)
	HAS PER DAY (INTERNAL)	
	HRS PER DAY (EVA)	
	MOT APPLICABLE	•
4.	RECONFIGURATION	
	INTERVAL DAYS TUTA	RECONFIGS.
	TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
	■ NOT APPL!CABLE	EVA HRS PER RECONFIG.
		EVA CREW SIZE
5.	DEACTIVATION/REMOVAL	
	DATE(S) 1994 INT. HRS.	EVA HRS EVA CREW
	NOT APPLICABLE	
2	NOTES IRRIEFLY DESCRIPE TASKS IN	1 TURNIGH & AROVE)

Shuttle/TMS retrieved

TOTAL EVA HRS ___0___

Code: GDCD 0061

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Solar Corona Diagostics Mission (SCDM)

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA liq., p. 19, RCVD 11/17/82

2. Nominal Mission Model, Rev 6, MSFC PSO1, 9/30/82

Narrative:

SCDM is assumed to be accommodated as a free-flyer.

The weight is from Ref 2 and is assumed to include orbit transfer propulsion.

The pointing, power, thermal control, data generation rate, and service interval are from the typical characteristics shown in Ref 1.

Remaining data derived.

	Page 1 of 3
PAYLOAD ELEMENT NAME Advanced Solar Observatory (ASO) 6 0 C 0 0 6	•
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division	Applications (non-commercial)
	- Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Technology
Approved Candidate Coportunity	•
First flight, yr 1995 No. of flights 1 Duration of Flight, days 2900	Importance of the Space Station to
OBJECTIVE	
To carry individual instruments capable of examining solar phenomena that can be pointed to regions of interest on the solar disc or throughout its atmosphere.	1 " low value but could use 10 - vital
	Scale 1 - 10 3
DESCRIPTION	
The ASO consists of the extreme ultra-violet telescope, the solar soft X-ray telescope, pin hole/occulter, and the solar optical telescope. The 57 degree inclination pushes it toward being a free flyer. Periodic maintenance and refurbishment can be performed by a station based OTV. Other options include final assembly and checkout at the station prior to placement in operational orbit.	ar soft X-ray telescope, ee inclination pushes it ent can be performed by a eckout at the station prior to

(1)					
CODE 6.0.0.0.6.2 Page 2 of	ORBIT CHARACTERISTICS Apogee, km 400 Tolerance + 35 30 Inclination, deg 57 Tolerance + 0 28.5 Nodal Angle, deg Ephemeris Accuracy, m Ephemeris Accuracy, m	OINTING/ORIENTA low direction ruth Sites (if ointing accurac ointing Stabili	OUER Ac Operating Standby Feak	MMUNICATIONS ing requirements! Realtime Of Yption/Decryption Require Ink Req.:Command Rate (K) Soard Data Processing Require	Data Types: Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 42,000 Downlink Frequency (MHZ)

	G D C D O O G 2 Page 3 of 3
THERMAL ———————————————————————————————————	
Remoter 1 TredX Unpressurize	3.8 Stowed Daployed
	XQE
Task Asslanme	
ls (Soo Table B) SKILL LEVEL	
Hrs/Day	
EUA 🗋 YES 🖾 NO Rouson	Hrs/EUA
Consumables,	kg 8
Interval, day Deliverables, kg.	Man/Hrs Rog. Returnables, kg
SPECIAL CONSIDERATIONS/500 Instructions	
If the majority of experiments could be performed at 28.5 degrees it makes a station occuption. Real time manual remote operation is desirable.	it makes a good candidate for e.

Volume II, Book 1 Appendix I

GDCD CODE 0062 ELEMENT NAME ADVA	NCED SOLAR OBSERVATORY
ACCOMODATION: ATTACHED S FREE FLY	ER DOTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	ACHMENT AND CHECKOUT)
DATE(S) 1995 INT. HRS EVA	HRSEV.A CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 720 DAYS TOTAL SERVICES	3
TMS/OTV MERNINGE Alternate	STATION HRS PER SERVICE8
□ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR M	IONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	·
■ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONFIGS.	
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) INT. HRS EVA H	RS EVA CREW
☑ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 A This payload element assumes accommon Leasecraft type spacecraft which has	odation on a platform or

5. Will remain in use past year 2000

Code: GDCD 0062

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Advanced Solar Observatory (ASO)

Reference Documents:

- Science and Applications Requirements for Space Station, NASA Hq., p. 20, RCVD 11/17/82
- 2. Science and Applications Space Platform Payload Accommodations Study, SP82-MSFC-2503 p. A-67, March 1982
- 3. LANL Discussion, December 1982

Narrative:

A free-flying accommodation is assumed primarily due to orbit inclination requirements although a station attached option is also suggested in Ref 1.

The crew-related data, launch and mission data, and special considerations are derived.

Remaining data from Ref (2).

The observatory as defined in Ref (2) is without supporting subsystems or orbit transfer propulsion and would require a Leasecraft-type spacecraft or alternatively platform accommodation.

The sketch is from Ref (2), with typical instruments from Ref (1) as follows:

SSXRTF = Solar soft x-ray telescope facility

SXUVTF = Solar extreme UV telescope facility

SOT = Solar optical telescope

P/OF = pinhole/occulter facility (not shown)

Although specific reconfiguration is not shown, the long life of this national facility suggests periodic changes of telescope instruments.

This payload element assumes accommodation on a platform or Leasecraft type spacecraft which has orbit transfer propulsion.

ORIGINAL PAGE IS

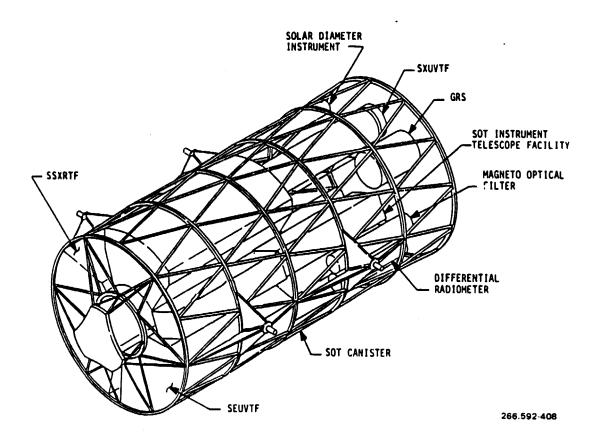
GDC-ASP-83-002

Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 0062

PAYLOAD ELEMENT SYNTHESIS

From Ref 2.



Advanced Solar Observatory

Section 1.2

Discipline Earth and Planetary Exploration

	,
GDCD ID NO.	PAYLOÅD ELEMENT NAME
	PLANETARY OBSERVATIONS
0103	Mars Geochemistry/Climatology Orbiter
0104	Mars Aeronomy Orbiter
0105	Venus Atmosphere Probe
0106	Lunar Geochemistry Orbiter
0107	Titan Probe
0108	Saturn Orbiter
0109	Mars Lander
0110	Saturn Probe
	SOLAR SYSTEM MISSIONS
0121	Comet T2 Rendezvous
0122	Main-Belt Asteroid Rendezvous
0123	Comet HMP Sample Return
0124	Near-Earth Asteroid Rendezvous
	EARTH DYNAMICS
	No payload elements identified in this Discipline.
	CRUSTAL MOTION
0151	Detection and Monitoring of Episodic Events
0152	Geoscience - Crustal Dynamics Studies
	GEOPOTENTIAL FIELDS
0161	Earth Science Research - Geophysical Investigation
	EARTH RESOURCES
0171	Renewable Resources - Earth Science Research

Section 1.2 (Continued)

Discipline Earth and Planetary Exploration

GDCD ID NO.	PAYLOAD ELEMENT NAME
0172	Operational Land Systems
0173	Shuttle Active Microwave Experiment (SAMEX-C)
0174	Earth Observations Instrument Development (Microwave Technology)
0175	Earth Observations Instrument Development (Extra Visible & Broad RF)
0176	EO Sensor/Techniques/Analysis/Automated System Development
0177	Geoscience-Geology Remote Sensing
0178	Reserv.ad
1079	Imaging Radar for Earth Resources Inventory & Monitoring
0180	Freeflying Imaging Radar Experiment (FIREX)
0181	Z-Continuous Coverage
0182	Z-Hydrologic Cycle Priority
0183	Z-Special Coverage
0184	Z-Continuous and Special Coverage

			Page 1 of
PAYLOAD ELEMENT NAME Mars Geochem/Climatol Orbiter		CODE 6 D C D 0 1 O 3	
CONTACT W. Hardy/J. Peterson NZ 21-9530 Namo General Dynamics Convair Divisi	uo		Applications (non-commercial)
San Diego, CA 92138	138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Ext. 3778/2130		Technology Development
STATUS Operational	N Planed	p	Operations
∪Approved	Candidate Opportunity	into cunity	Type Number 2
First flight, yr 1992 No. of flights 1 Duration of Flight, da	S) ha		(See Table A) Importance of the Space Station to this Element
To characterize the surface graphy, and gravity of the tiles history of the atmosp	surface composition, magnetic field, topo- of the planet and define the seasonal vola- atmosphere as well as overall climate.	tic field, topo- he seasonal vola- rall climate.	1 = low unlum but could use 10 = vital
			Scale 1 - 10 5
An orbiting spacecraft, with a broad and integrated set of geophysical and geochemical s is an essential element in the exploration of Mars. Studies of the planetary interior, face, atmosphere, and plasma environment all depend heavily on data acquired from orbit. unique contribution of the orbiter is its ability to characterize the planet on a global basis.	ift, with a broad and integrated set of geophysical and geochement in the exploration of Mars. Studies of the planetary intend plasma environment all depend heavily on data acquired from of the orbiter is its ability to characterize the planet on a	rated set of geophy. Mars. Studies of tl epend heavily on da ity to characterize	An orbiting spacecraft, with a broad and integrated set of geophysical and geochemical sensors, is an essential element in the exploration of Mars. Studies of the planetary interior, surface, atmosphere, and plasma environment all depend heavily on data acquired from orbit. The unique contribution of the orbiter is its ability to characterize the planet on a global basis.

of 3						ПП	
0.1.0.3 Page 2 of				Continuous	Frequency (MHZ)		(241
CODE 6 D C D 0 1 0 3	Tolerance + Ephemeris Accuracy,	□Earth Field of view, deg —	Duration, hrs/day	# # # # # # # # # # # # # # # # # # #	ther	Uoica (Hrs/Day) Other	Downlink Frequency (MHZ)
	Perigee, km LEO 28.5 To m/s 3380 Epi	Sotar	3	Frequen	Offline Required (ate (KBS) ing Required	gite	equency (Per Orbit) te (KBPS)
	ORBIT CHARACTERISTICS Apoges, km LEO Pers Inclination, deg 28.5 Nodal Angle, deg Escape dV Required,m/s	ENTATION (1f known aracy, a	Jeniii Restrict	Operating Standby Peak Voltage, V	DATA/COMMUNICATIONS Monitoring requirements! XNone Realtime [Encryption/Decryption Re Uplink Req.: Command Rate On-Board Data Processing	413 c	R

CODE 6 0 1 0 3 Page 3 6 3
Remote red XUnpressurized H, m
s stivitu.
Task Assignment
Skills (Soo Table B) SKILL 7 7 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Hrs/Day 4
EUA LIYES XINO Rouson Hrs/EUA
NGESiInterval, day
lons
Station involvement with Spacecraft ends with launch from LEC into escape trajectory. A ground data link is required for prelaunch checkout. No communication required after launch. No servicing required.

Volume II, Book 1
Appendix I

ACCOMODATION: ATTACHED SFREE FLYER OTV OPS 1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT) DATE(S) 1992 INT. HRS EVA HRS EVA CREW NOT APPLICABLE 2. SERVICE (E.G., REPLENISH/RESUPPLY)	
DATE(S) 1992 INT. HRS EVA HRS EVA CREW	
NOT APPLICABLE 2. SERVICE (E.G., REPLENISH/RESUPPLY)	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	
TMS/OTV REQUIRED STATION HRS PER SERVICE	
☑ NOT APPLICABLE EVA HRS PER SERVICE	
EVA CREW SIZE	
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.) 8 HRS PER DAY (INTERNAL) 14 RS PER DAY (EVA) NOT APPLICABLE	
4. RECONFIGURATION INTERVAL DAYS TOTAL RECONFIGS TMS/OTV REQUIRED STATION HRS PER RECONFIG NOT APPLICABLE EVA HRS PER RECONFIG	
5. DEACTIVA'I ION/REMOVAL DATE(S) INT. HRS EVA HRS EVA CREW ANOT APPLICABLE	

- 6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)
 - 3. Station involvement is for mating of spacecraft with upper stage (OTV or equivalent) using RMS or equivalent. Station could store spacecraft until ready for mating. Involvement ends with launch from LEO into escape trajectory. No station resources are required, however a spacecraft-to-ground data link is required for checkout. Two men required (4 hours each) for 1 day.

TOTAL	C1/ A	uee	n
INIAI	SVA	M 0 6	U

Code: GDCD 0103

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Mars Geochemistry/Climatology Orbiter

Reference Documents:

 MSFC Letter, D. Saxton To Boeing and GDC, "Planetary Mission Requirements for OTV," 7/30/79

- 2. Paper, Astronautics and Aeronautics Journal, Jesse W. Moore (NASA), "Effective Planatary Exploration at Low Cost," Oct 1982
- S.A.I. Report No. SAI 1-120-340-T19, Sept 1982; Telecon, J. Neihoff, Oct. 1982
- 4. MSFC, Solar System Exploration Scenario, Sept 1982; GDC Visit, Oct 1982
- 5. JPL Internal Memo, A.Y. Nakata, "Mariner Mark II Preliminary Mission Requirements Report," Rev 2, 10/1/82; GDC Visit, Oct 1982
- J. Solar System Exploration Committee Recommended Core Program, Nov 1982

Narrative:

This payload element is recommended in the Ref 6 program, judged to be most authorative planning document on planetary and solar system exploration available at this time. The objectives and rationale were obtained from Ref 5. Technical data are given in Ref 3, pp 43-45. Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launched from the shuttle with existing upper stage vehicles. However, the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

Ref 1, 2 and 4 also identify this mission.

	Page 1 of 3
PAYLOAD ELEMENT NAME Mars Aeronomy Orbiter	
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division	Applications (non-commercial)
San Diego, CA 92138	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Tachnology Days
☐ Operational ☐ ☐ Candidate	Upperations
	Type Number 2
First flight, yr 1992 No. of flights 1 Duration of Flight, days 1	(see Table A) Importance of the Space Station to
	4
To survey the upper atmosphere and solar wind interaction, as well as the magnetic field of the planet.	1 = low value but could use 10 = vital
	Scale 1 - 10 5
DESCRIPTION	
This mission augments the Mars geochemistry/climatology orbiter in the unmanned exploration of the planet. It will provide global coverage plus a time history of the dynamics of the planet's upper atmosphere and magnetic field.	n the unmanned exploration ry of the dynamics of the

., 4

CODE 6 0 0 0 0 0 4 Page 2 of 3	Perigeo, km LEO Tolerance + 28.5 28.5 Ephemeris Accuracy, m	TION Institut Solar Earth Finown) y,arc sec ty (Jitter)arc sec/sec	Duration, hrs/day Continuous Frequency, Hz	NS oments: Realtime Of cryption Requir ommand Rate (K) Processing Rec	Analog Digital Hrs/Day Ooice (Hrs/Day) Other Ownlink Frequency (MHZ) Ownlink Frequency (MHZ)
	ORBIT CHARACTERISTICS Apogee, km LEO Perigee, kn Inclination, deg 28.5 Nodal Angle, deg 3380	CINTING/ORIENTAL 10w direction ruth Sites (if) ointing accuracy ointing Stabili	POWER Gerating Generating Standby Feak	MUNICATIONS ng requirements: Realtime Retion/Decryption Requirement Rate oard Data Processing	Data Types: Analog Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per O

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PHYSICAL CHARACTERISTICS	
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IREMENTS	
Craw Size 2 Task Assignment	
Skills (See Table B) SKILL 7 7 7	
LEVEL 3 2	
Hrs/Day 4 4	
EUA TYES XNO Reason	
NCE	
SERVICE: Interval, days Consumables, kg	
33, kg Man Hours	
Deliverables, kg Returns	
ith Spacecraft ends with launch from LEO into escape trajectory	
ed for prelaunch checkout.	

Volume II, Book 1 Appendix I

G	OCD CODE	0104		ELEMENT NAME	MARS A	ERONOMY	CRBITER		
A(COMODA	TION:	ATTACI	HED 🔼 FRI	EE FLYER	ντο 🗷	Q PS		
1.	STATION	ACTIVA	TION (E.G., SI	ET-UP/ASSEMBL	Y/ATTACHI	ENT AND	CHECKOUT)		
	DATE(S)	1992	INT. H	RS	_ EVA HRS		EVA CREW	·	
	□ NO:	T APPLIC	ABLE	-	-				
2.	SERVICE	(E.G., RE	PLENISH/RE	SUPPLY)					
	INTERVA	\L	_ DAYS	TOTAL SERVIC	ES				
	□ TM	S/OTV RE	QUIRED		ST	ATION HR	S PER SERVICE		
	⊠ NO	T APPLIC	ABLE		5,	/A HRS PER	SERVICE		
					E,	/A CREW SI	ZE		
3.	STATION	OFERAT	TONAL SUPP	ORT (AVG. TIME	FOR MONI	TOR, INSPE	CT, ETC.)		
	8	HRS PE	ER DAY (INTE	ERNAL)					
			AVA) YAG RE					•	•
	□ NO	T APPLIC	ABLE						
4.	RECONFI	GURATI	ON						
	INTERVA	\L	DAYS	TOTAL RECOM	IFIGS.				
	☐ TM:	S/OTV RE	QUIRED		ST	ATION HRS	PER RECONF	lG	
	⊠ NO	T APPLIC	ABLE		EV	A HRS PER	RECONFIG.		
					EV	A CREW SIZ	ZE		
.5 .	DEACTIV	ATION/R	EMOVAL						
	DATE(S)		INT. HE	RS	EVA HRS		_ EVA CREW		
							<u>-</u>		
	⊠ NO	T APPLIC	ABLE						
6.	NOTES (E	BRIEFLY	DESCRIBE TA	ASKS IN 1 THRO	UGH 5 ABO	VE)			
	(0° spa	TV or o	equivaler ft until	nt) using ready for	RMS or mating.	equival Involv	ent.Stati ement end	h upper stage on could store s with launch round data li	

is required for checkout.
Two men required (4 hours each) for 1 day.

TOTAL EVA HRS _____0

Code: GDCD 0104

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Mars Aeronomy Orbiter

Reference Documents:

1. MSFC Letter, D. Saxton To Boeing and GDC, "Planetary Mission Requirements for OTV," 7/30/79

- 2. Paper, Astronautics and Aeronautics Journal, Jesse W. Moore (NASA), "Effective Planetary Exploration at Low Cost," Oct 1982
- 3. S.A.I. Report No. SAI 1-120-340-T19, Sept 1982; Telecon, J. Neihoff, Oct 1982
- 4. MSFC, Solar System Exploration Scenario, Sept 1982; GDC Visit, Oct 1982
- 5. JPL Internal Memo, A.Y. Nakata, "Mariner Mark II Preliminary Mission Requirements Report," Rev 2, 10/1/82; GDC Visit, Oct 1982
- 6. Solar System Exploration Committee Recommended Core Program, Nov 1982

Narrative:

This payload element is recommended in the Ref 6 program, judged to be most authorative planning document on planetary and solar system exploration available at this time. The objectives and rationale were obrained from Ref 5. Technical data are given in Ref 3, pp 43-45. Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launched from the shuttle with existing upper stage vehicles. However, the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

Ref 1, 2 and 4 also identify this mission.

	Page 1 of 3
PAYLOAD ELEMENT NAME G.D.C.D.O.1.0.5, Venus Atmosphere Probe	TYPE
. Peterson MZ 21-9530 namics Convair Division	Applications (non-commercial)
Addross P.O. Box 85357 San Diego, CA 92138	- Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Technology Development
STATUS Deparational Planned	Operations
☐ Approved ☐ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Type Number
First ilight, yr 1993 No. of flights 1 Duration of Flight, days 1	(see Table A) Importance of the Space Station to
	this Element
To determine the concentration of photochemically active gases and investigate the composition and formation of atmospheric aerosols.	1 - low value but could use 10 - vital
	Scale 1 - 10 5
DESCRIPTION	
The harsh Venusian environment has thus far yielded only limited information on the planets atmospheric structure and dynamics. The Venus atmosphere probe mission is directed by enhancement of this knowledge through improved capability to endure the ambient conditions and superior instrumentation to sense and transmit critical data.	information on the planets ission is directed by en- the ambient conditions and

6.0.C.0.0.1.0.5. Page 2 of 3			Continuous	Frequency (MHZ)	(2)
(CODE (P)	Apogee, km LEO Perigee, km LEO Tolerance + Inclination, deg 28.5 Tolerance + Apogee, deg Ephemeris Accuracy, Escane do Required.m/s	ING/ORIENTA direction Sites (if ing accuracing Stabili	OUER OPERE Stand	UNICATIONS graduirements; —Realtime Offiine Other ption/Decryption Required k Req.:Command Rate (KBS) and Data Processing Required	Data Types! Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

3 of 3		79						A ground No
P		Stowed Deployed					kg	
0 0 1 0 5		X de la constant de l					Man/Hrs Rog.	e traject after la
CODE 6 D C	X X X X A A A A A A A A A A A A A A A A	pe pe			Hrs/EUA	ł	, , ,	TIONS/Soo Instructions ith Spacecraft ends with launch from LEO into escape trajectory. for prelaunch checkout. No communication required after launch
		ERISTICS External Remote PressurizedX Unpressurized U, m H, m U, m H, m Hass, kg oles Types	9 x	2	4	Consummples,	Hours	om LEO ir Inication
	# # # # # # # # # # # # # # # # # # #	Los Remote urized Vunpres U, m Los Markg	Assignment	3	4	1	1, 5	ons launch fr No commu
·		ornal ssurize W,m W,m X,m Y,m Y,m Y,m	Task	درد	Day		yab .	ttruct1 nds with neckout.
•	Passive operationa non-operationa operationa	CHARACTERISTICS nat Externation Lon Pressuri L,m U, L,u M U, Launch mass, kg Consumables Type Acceleration ser		SKILL	Reason		nterval	TIONS/Soo Instructions ith Spacecraft ends with laufor prelaunch checkout. No
	ີບຸ	الله الله الله الله الله الله الله الله] [(B)	N N	NANCE days	U <u>Z</u>	ATIONS/ With Spac d for pre
	5) 8	PHYSICA ID/Func	REQUIREMENTS Size	Skills (Soo Tablo	(5)	SENUICING/MAINTENANCE SERVICE: Interval, day	sturnab TION CH	SPECIAL CONSIDERA Station involvement wi data link is required servicing required.
	THERMAL	EQUIPMENT Location: Equipment	ř	11s (Se	□ YES	UICING, UICE 1 I	Return CONFIGURATION	SPECIAL CONSIDE Station involvement data link is requir servicing required.
	THE Tam Hea	Equ Equ	CREU	Ski	EUA	SER SER	CON	Stat Stat data serv

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1
Appendix I

GD	OCD CODE 0105	ELEMENT NAME	VENUS /	ATMOSPHER	RE PROBE		_
AC	COMODATION:	ATTACHED X FRE	E FLYER	Ø o⊤v o	PS		
1.	STATION ACTIVATION	(E.G., SET-UP/ASSEMBLY	/ATTACHN	IENT AND CH	IECKOUT)		
	DATE(S) 1993	INT. HRS	EVA HRS		_ EVA CREV	N	-
			•		-		-
	☐ NOT APPLICABLE						
2.	SERVICE (E.G., REPLEN	ISH/RESUPPLY)					
	INTERVAL DAY	S TOTAL SERVICES	š				
	TMS/OTV REQUIR	IEO	ST	ATION HRS P	ER SERVIC	Ε	-
	■ NOT APPLICABLE	-	EV	A HRS PER S	ERVICE		_
			Ę٧	A CREW SIZE	E	**********	- .
3.	STATION OPERATIONA	L SUPPORT (AVG. TIME	FOR MONIT	TOR, INSPECT	r, etc.)		
	8 HRS PER DA	Y (INTERNAL)					
	HRS PER DA						•
	☐ NOT APPLICABLE						
4.	RECONFIGURATION						
	INTERVAL DAY	S TOTAL RECONF	igs				
	TMS/OTV REQUIR	ED	STA	TION HRS P	ER RECONF	IG	_
	▼ NOT APPLICABLE		EV	A HRS PER RI	ECONFIG.		-
			EV	A CREW SIZE			_
5	DEACTIVATION/REMOV	/A1					
		INT. HRS	EVA HBQ		EVA CREW		
	Un (E (0)	IIVI. ANG.	- vu uvo _	·	EAW OUEIA		-
	NOT APPLICABLE		-				-
6.	NOTES (BRIEFLY DESCI	RIBE TASKS IN 1 THROU	GH 3 ABOV	'E)			

3. Station involvement is for mating of spacecraft with upper stage (OTV or equivalent) using RMS or equivalent. Station could store spacecraft until ready for mating. Involvement ends with launch from LEO into escape trajectory. No station resources are required, however a spacecraft-to-ground data link is required for checkout. Two men required (4 hours each) for 1 day.

TOTAL EVA HRS ______

Code: GDCD 0105

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Venus Atmosphere Probe

Reference Documents:

1. Solar System Exploration Committee Recommended Core Program, Nov 1982

2. NASA Lunar and Planetary Mission Handbook, Volume IV, May 1979

Narrative:

This is a recommended mission in the Ref l program. An additional Venus mission, the Venus radar mapper, is also one of the recommended missions but is planned in the pre-space-station time frame, It was therefore not included as a payload in this study. Ref 2, sections VLB and VSR, was used for mission objectives and background information.

Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launcard from the shuttle with existing upper stage vehicles. However the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

	Page 1 of 3
PAYLOAD ELEMENT NAME Lunar Geochemistry Orbiter 6 0 0 0 0 6	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division Address P.J. Box 85357	Applications (non-commercial)
	- Commercia!
Telephone (619) 277-8900, Ext. 3778/2130	O Tachnology
STATUS Oberational	
۔ ۔	Tube Number 2
First flight, yr 1993 No. of flights 1 Duration of Flight, days 1	Importance of the
he surf	
	10 - vital Scale 1 - 10 5
DESCRIPTION The Moon is now viewed as a representative of a large class of planetary objects. It is one of a number of intermediate-size bodies, and it is grouped with objects of intermediate density that include lo and Europa, but it is clearly separated from denser Mercury and larger Mars. Because density is closely related to bulk composition, the Moon is an important compositional representative of a class of solar system objects. Thus, the Moon offers us an accessible laboratory for studying similar planetary processes. A basic point in the scientific rationale for a lunar polar orbiter mission is that the Earth-Moon system is, and will remain for the foreseeable future, the tie-point for planetological comparisons. This is true because we have information about these bodies that will be obtainable for must other planets in any approaching the depth of that available for the Earth and Moon.	objects of intermediate den- by denser Mercury and larger the Moon is an important com- ints, the Moon offers us an iter mission is that the Earth-Moor obint for planetological compari- ies that will be obtainable for le for the Earth and Moon.

GDCDDE Pege 2 of 3
Parigos, km LEO
dog Ephemeris Accuracy, m
NTA ATA
ruth Sites (If Ointing accura Ointing Stabil
AC
ndby Frank
NS Oments!
Chone Cryption Required Frequency (MHZ) Command Rate (KBS) Command Data Processing Required Description
Data Types: Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day)
On-Board Storage (MBII) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

CODE 6 D C D O 1 O 0 D O 1 O 6 D C D O 1 O 0 0 D O 1 O 0 0 D O 1 O 0 0 D O 1 O 0 0 D O 1 O 0 0 D O 1 O 0 0 D O 1 O 0 0 D O 1 O 0 0 D O 1 O 0 0 D O 1 O 0 0 D O 1 O 0 0 D O 1 O 0 0 D O 1 O 0 D O 1 O 0 D O 1 O 0 D O 1 O 0 D O 1 O 0 D O 1 O 0 D O 1 O 0 D O 1 O 0 D O 1 O 0 D O 1 O 0 D O 1 O 0 D O 1 O 0 D O 1 O 0 D O 1 O 0 D O 1 O 0 D O 1 O 0
THERMAL ———————————————————————————————————
S Remote TrodX Unpressurized M.M. H.M. M.M. M
EUA TYES XNO Reason
Consumables
ESiInterval, day Dollverables, kg
lons h launch from LEO int . No communication r

C Oi

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Appendix I

GDCD CODE 0106	ELEMENT NAME	LUNAR GEOCHEMISTRY ORBI	TER
ACCOMODATION: ATT	ACHED E FREE	FLYER TO OTV OPS	
		ATTACHMENT AND CHECKOUT) EVA HRS EVA CREW	-
NOT APPLICABLE		44411	
2. SERVICE (E.G., REPLENISH/			•
TMS/OTV REQUIRED_		STATION HRS PER SERVICE	
MOT APPLICABLE _		EVA HRS PER SERVICE	
		EVA CREW SIZE	
3. STATION OPERATIONAL SU 8 HRS PER DAY (IN HRS PER DAY (ST	ITERNAL)	OR MONITOR, INSPECT, ETC.)	
4. RECONFIGURATION INTERVAL DAYS TMS/OTV REQUIRED MOT APPLICABLE	TOTAL RECONF	IGS. STATION HRS PER RECONFI EVA HRS PER RECONFIG.	
2 HOT ATTERANCE		EVA CREW SIZE	
	HRS 6	EVA HRS EVA CREW _	
■ NOT APPLICABLE			

- 6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)
 - 3. Station involvement is for mating of spacecraft with upper stage (OTV or equivalent) using RMS or equivalent. Station could store spacecraft until ready for mating. Involvement ends with launch from LEO into escape trajectory. No station resources are required, however a spacecraft-to-ground data link is required for checkout. Two men required (4 hours each) for 1 day.

٢	0	T	N	L	E١	۷	A	Н	R	S		<u>C</u>)	
---	---	---	---	---	----	---	---	---	---	---	--	----------	---	--

Code: GDCD 0106

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Lunar Geochemistry Orbiter

Reference Documents:

 Paper, Astronautics and Aeronautics Journal, Jesse W. Moore (NASA), "Effective Planetary Exploration at Low Cost," Oct 1982

- 2. Solar System Exploration Committee Recommended Core Program, Nov 1982
- 3. NASA Lunar and Planetary Mission Handbook, Volume IV, May 1979

Narrative:

This is a recommended mission in the Ref 2 program. Program objectives and description were obtained from Ref 3 section LPO. The launch date in the payload sheets is arbitrary since a launch opportunity occurs every month. Ref 1 also identifies this as a recommended mission.

Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launched from the shuttle with existing upper stage vehicles. However the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

			Page 1 of
PAYLOAD ELEMENT Titan Probe	NAME	CODE 6 D C D O 1 O 7	•
CONTACT Name Address	W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division		Applications (non-commercial)
	r.u. bux bass/ San Diego, CA 92138		- Commercial
Telephone	(619) 277-8900, Ext. 3778/2130		Technology Development
STATUS	5 		
Approved	oved Scandidate Opportunity	iate insty	Type Number
First flight, yr No. of flights Duration of Fligh	1995 1 days		(See Table A) Importance of the
OBJECTIVE			lomont
To determine Saturn's moon homogeneity o	To determine the chemical composition of the atmosphere of Saturn's moon, Titan, and characterize the physical state and homogeneity of its surface.	tmosphere of sical state and	1 = low value but could use 10 = vital
·			Scale 1 - 10 5
DESCRIPTION Titan's atmosphere repratmosphere of earth. Tatmosphere are unknown.	ohere rep earth. e unknowr	ich probably comes c e and precise chemic is best suited to p	presents a composition which probably comes closest to the primordial. The nature of the surface and precise chemical composition of the lower.

na na いるかん タトツバル

GDC D 1 0 7 Page 2 of 3		☐Solar ☐Earth _Field of view, deg	U Duration, hrs/day □Continuous	line Other Frequency (MHZ)	Digital Hrs/Day Voice (Hrs/Day) Other Other
	ORBIT CHARACTERISTICS Apogee, km LEO Perigee, km Inclination, deg 28.5 Nodal Anrie, deg Escape de Required, m/s 7390	ENTATION On Inertial (If known) uracy, arc sec bility (Jitter) arc	□ DC Power,	UNICATIONS grequirements;	Data Types: Ant log Dig

CODE 6.0.0.0.1.0.7. Page 3 of
THERMAL Control Passive Passive Passive Temperature, deg C operational min max max
RACTERISTICS Remote Pressurize
Lym Lym Lym Hym Stowed
ables Types ration sensitivity, a m
Task Assignment
B) SKILL
Hrs/Day 4 4
EUA DYES XNO Reuson Hrs/EUA
1CE
SERVICE: Interval, days Returnables, kg
Estinterval, day
les, kgReturnal
Station involvement with Spacecraft ends with launch from LEO into escape trajectory. A ground data link is required for prelaunch checkout. No communication required after launch. No

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GD	CD CODE	0107		ELEME	NT NAME	TITAN	PROBE			
AC	COMODA	TION:	☐ AT	TACHED	X FRE	E FLYER	⊠ 0 T V 0	PS		
1.	STATION	ACTIVAT	ION (E.	G., SET-UP/	ASSEMBLY	//ATTACH	MENT AND CI	HECKOUT)		
	DATE(S)	199	<u>5</u> in	IT. HRS		EVA HRS	·	_ EVA CREW		
								_		
	□ NO.	T APPLICA	ABLE							
2.	SERVICE	(E.G., RE	PLENISI	H/RESUPPL	Y)					
	INTERVA	\L	DAYS	TOTAL	SERVICE	s				
	☐ TM	S/OTV RE	QUIRE)		S	TATION HRS	PER SERVICE		
	⊠ N0	T APPLICA	ABLE		_	Ε	VA HRS PER	SERVICE	***	
						ε	VA CREW SIZ	E		•
3.	STATION	OPERAT	IONAL	SUPPORT (A	VG. TIME	FOR MON	ITOR, INSPEC	T, ETCJ		
	8	HRS PE	R DAY	(INTERNAL	.)					
		 HRS PE	R DAY	(EVA)			÷			
	□ NO	T APPLICA	ABLE						•	
4	DECONE	IGURATIO) AL							
				TOTA	AL RECON	FIGS.				
	_	S/OTV RE	_					ER RECONFI	IG	
		T APPLICA					/A HRS PER R			
			,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,				/A CREW SIZE			
5.		ATION/R								
	DATE(S)		IN	IT. HRS		EVA HRS		EVA CREW		
	⊠ NO	T APPLICA	ABLE	_				•		٠
6.	NOTES (6	RIEFLY	DESCRI	BE TASKS II	N 1 THROL	IGH 5 A80	VE)			
	3. Sta (0' spa fro	ation TV or e acecrai om LEO wever a	involvequiva equiva ft und into into	vement i alent) til reac escape cecraft-	s for a using ly for a traject to-grow	mating RMS or mating. tory. und dat	of spaced equivale Involve No statio	ent.Stati ement end on resour	h upper st on could s s with lau ces are re d for chec	tore inch ouired.

TOTAL EVA HRS _____0

Code: GDCD 0107

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Titan Probe

Reference Documents:

1. MSFC Letter, D. Saxton to Boeing and GDC, "Planetary Mission Requirements for OTV." 7/30/79

- Paper, Astronautics and Aeronautics Journal, Jesse W. Moore (NASA), "Effective Planetary Exploration at Low Cost," Oct 1982
- 3. S.A.I. Report No. SAI 1-120-340-T19, Sept 1982; Telecon, J. Neihoff, Oct 1982
- 4. MSFC, Solar System Exploration Scenario, Sept 1982; GDC Visit, Oct 1982
- 5. JPL Internal Memo, A.Y. Nakata, "Mariner Mark II Preliminary Mission Requirements Report," Rev 2, 10/1/82; GDC Visit, Oct 1982
- 6. Solar System Exploration Committee Recommended Core Program, Nov 1982

Narrative:

This is a recommended mission in the Ref 6 program. Program objectives and description were obtained from Ref 5 section 2.6. Technical data are given in Ref 3, pp 89 and 90.

Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launched from the shuttle with existing upper stage vehicles. However the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

Ref !, 2 and 4 also identify this mission.

		Page 1 of 3
PAYLOAD ELEMENT NAME Saturn Orbiter	CODE 6 D C D 0 1 0 8	TYPE
W. Hardy/ General C		Applications (non-commercial)
Hddrdss P.O. Box 85357 San Diego, CA 92138		- Commercial
Telephone (619) 277-8900, Ext. 3778/2130		☐ Technology Development
nal	Planed	Operations
First flight, yr 1997 No. of flights 1 Duration of Flight, days 1		Importance of the Space Station to
OBJECTIVE To characterize the dynamic behavior of the assembly of satel-	te]-	this Element 1 - low calus but
lites, field, and rings which comprise this complex planet system.	is complex planet	could use 10 - vital
		Scale 1 - 10 5
DESCRIPTION Voyager missions provided instantaneous glimpses of the Saturn system. An orbiter mission is required to understand the dynamics of this complex assembly of satellites, field phenomena, rings, and giant planet. This mission will orbit a Spacecraft about Saturn that	instantaneous glimpses of the Saturn system. the dynamics of this complex assembly of sate. This mission will orbit a Spacecraft about	instantaneous glimpses of the Saturn system. An the dynamics of this complex assembly of satellites, This mission will orbit a Spacecraft about Saturn
ror long duration study. The mission will reacure repeated close encounters with intain, the conty large body in the solar system with a nitrogen atmosphere, except for Earth. A better understanding of Titan's atmosphere will provide basic information on how Titan evolved and allow a unique comparison and insight into Earth's evolution.	n realure repealed close a nitrogen atmosphere, e) provide basic information o Earth's evolution.	kcept for Earth. A better n on how Titan evolved and

6				<u> </u>	
Page 2 of			□ Continuous		
			Con	- (ZHW)	(2)
CODE G D C D 0 1 0 8	orance + Accuracy, m	geb	Aup 	Frequency (MHZ))
[S ₀]	Tolerance Ince + Iris Accure	□Earth of view,	Duration, hrs/day	,	Voice (Hrs/Day) Uoice (Hrs/Day) Other Downlink Frequency (MHZ)
	Tolerance Ephemeris	Field	Duratio Duratio	Other	Voice (
	LEO	Solar sec/sec	U Durat	Offline quired Required	47 B
	Periges, km 28.5	tial c	Power,	R Reg	log Dig
	STICS Perit 28.5	TION Institat)a	NS ements Realti crypti ommand Proce	Analog //Day) rage (MBIT) equency (Pe
	deg deg	NTA LL LL	5 0	A/COMMUNICATION to the control of th	Sto Fr
	ORBIT CHARACT Apogee, km Inclination, Nodal Angle, Escane du Ree	POINTING/ORIEN Usew direction Truth Sites (I Pointing accur Pointing Stabi	POWER Operation Standby	Monitoring requi	Data Types Film (Amou Live TU (F On-Board S Data Dump Recording
	S O U U U U U U U U U U U U U U U U U U	Pol	Po Po	0 £ 6 0	

0 0 0 9 0 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0	CODE G D C D 0 1 0 8 Page 3 of 3
THERMAL Passive	
deg C operational min	
Heat Rejection, w operational min	
S Remote	
	Stowed
sumables T	
Acceleration	Max
CREW REQUIREMENTS 2	
Skills (See Table B) SKILL 7 7 7	
LEVEL 3 2	
Hrs/Day 4 4	
EUA TYES XNO Reason Hrs/EUA	
Cons	
CONFIGURATION CHANGES: Interval, day	Rog.
, kg	iblos, kg
tions	
_	•
servicing required.	atter launch. No

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G	CD CODE_	0108		ELEME	NT NAME	SATUR	N ORBITE	R		
A(COMODAT	ION:	□ ΑΠΑ	CHED	X FRE	E FLYER	⊠ 0TV 0	OPS		
1.	STATION A	ACTIVATI	ON (E.G.,	SET-UP/	ASSEMBLY	/ATTACHN	IENT AND C	HECKOUT)		
	DATE(S)_	1997	INT.	หลร		EVA HRS		EVA CREW		
						•		_		
	U NOT	APPLICA	BLE.							
2.	SERVICE (E.G., REP	LENISH/R	ESUPPL	Y)					
	INTERVAL	-	DAYS	TOTAL	SERVICE	s				
	☐ TMS	OTV REC	LUIRED _			ST	ATION HRS	PER SERVICE		
	⊠ not	APPLICA	8LE _			EV	A HRS PER	SERVICE		
						E/	A CREW SIZ	E		
3.	STATION	OPERATIO	ONAL SUP	PORT (A	VG. TIME	FOR MONI	TOR, INSPEC	T. ETC.)		
	_	_HRS PER						,		
		_HRS PER			•					
	_	APPLICA		•					•	
4.	RECONFIG		•							
	_			TOTA	L RECON	FIGS				
		OTV REQ				STA	ATION HRS P	'ER RECONFI	G	
	⊠ NOT	APPLICA	BLE			EV	A HRS PER R	ECONFIG.		
•						EV.	A CREW SIZE	E		
5.	DEACTIVA	TION/RE	MQVAL							
	DATE(S)_		INT. I	HRS		EVA HRS _		EVA CREW		
	_			_		_				
	🔼 NOT	APPLICA	BLZ							
6.	NOTES (BF	RIEFLY DI	ESCRIBE '	TASKS IN	I 1 THROU	IGH 5 ABOV	/E)			
	(OT spa fro how	V or e cecraf m LEO ever a	quivale t unti into e: space	ent) l read scape craft-	using y for d traject to-grou	RMS or mating. tory. I	equivale Involve No statio	ent Stati ement end on resour	th upper sta on could st Is with laun ces are req d for check	ore ich juired,

TOTAL EVA HRS 0

Code: GDCD 0108

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Saturn Orbiter

Reference Documents:

1. MSFC Letter, D. Saxton to Boeing and GDC, "Planetary Mission Requirements for OTV," 7/30/79

- Paper, Astronautics and Aeronautics Journal, Jesse W. Moore (NASA), "Effective Planetary Exploration at Low Cost," Oct 1982
- 3. S.A.I. Report No. SAI 1-120-340-T19, Sept 1982; Telecon, J. Neihoff, Oct 1982
- 4. MSFC, Solar System Exploration Scenario, Sept 1982; GDC Visit, Oct 1982
- 5. JPL Internal Memo, A.Y. Nakata, "Mariner Mark II Preliminary Mission Requirements Report," Rev 2, 10/1/82; GDC Visit, Oct 1982
- 6. Solar System Exploration Committee Recommended Core Program, Nov 1982

Narrative:

This is a recommended mission in the Ref 6 program. Objectives and description used material from Ref 5, Section 2.7.

Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launched from the shuttle with existing upper stage vehicles. However the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

Ref 1, 2, 3, and 4 also identify this mission.

		Page 1 of 3
PAYLOAD ELEMENT NAME Mars Lander	CODE 6 D C D O 1 0 9	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-95.0 Name General Dynamics Convair Division Address P. D. Roy, 8436.7		Applications (non-commercial)
San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		☐ Technology Development
STATUS	-	Operations
	ato unity	Type Number 2
First flight, yr 1997 No. of flights 1 Duration of Flight, days 1		(see Table A) Importance of the Space Station to
		this Element
To determine the bulk composition, surface structure, and weather of the planet.	icture, and	1 . low value but could use 10 . vital
		Scale 1 - 10 5
DESCRIPTION This mission will augment the Mars orbiters with detail measurements at the	h detail measuremen	its at the planet's surface.

CODE GO 1 0 9 Page 2 of 3 CHARACTERISTICS Ination, deg 28.5 Character Tolerance + Tolerance + Ephemeris Accurrcy, m Ephemeris Accurrcy, m	NTA LIF LIF LOT	Operating Duration, hrs/day Operating Standby Continuous Peak	ING requirements: Realise Of	lata Types! Analog Digital Hrs/Day Tilm (Amount) Live TU (Hrs/Day) In-Board Storage (MBIT) Detaing Rate (KBPS) Other Downlink Frequency (MHZ)
ORBIT CHARACT Apoges, km Inclination, Nodel Angle, Escape du Req	POINTING Usew dir Truth SI Pointing Special	POUER Ope Sta	Montorioriorioriorioriorioriorioriorioriorio	Data Clica On-Bo Recor

and the second of the second

CODE 6.0 C.0.0.1.0.9 Page 3 of	(n)
THERMAL []Active	
rnal Remote surized Unpressurized U,m H,m 1700 kg	
REQUIREMENTS Tack Assignment	
oo Tablo B) SKILL LEVEL Hrs/Day	
□ YES 医治的 Resson	
rtenance ral, days Consumables, kg	
CONFIGURATION CHANGESTIAterval, day Returnables, kg Deliverables, kg	
lons	
Station involvement with Spacecraft ends with launch from LEO into escape trajectory. A ground data link is required for prelaunch checkout. No communication required after launch. No servicing required.	

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GDCD CODE_	0109	ELEME	NTNAME	MARS	LANDER			
ACCOMODAT	ION: 🗆	ATTACHED	X FRE	E FLYER	Ø 0TV 0	PS		
1. STATION	ACTIVATION	(E.G., SET-UP/	ASSEMBLY	//ATTACHN	IENT AND CH	ECKOUT)		
DATE(S)_	1997	INT. HRS		EVA HRS		EVA CREW		
-						-		
□ NOT	APPLICABLE					•		
2. SERVICE	(E.G., REPLE	NISH/RESUPPL	Y)					
INTERVA	LDA	YS TOTA	L SERVICE	s				
☐ TMS	OTV REQUI	RED		\$T	ATION HRS P	ER SERVICE		
⊠ not	APPLICABLE	·		E/	A HRS PER S	ERVICE		
				E/	A CREW SIZE	:		
3. STATION	OPERATIONA	AL-SUPPORT (A	VG. TIME	FOR MONI	TOR, INSPECT	, ETC.)		
		AY (INTERNAL						
	HRS PER O					_		
	APPLICABLE							
_								
4. RECONFIC		YS TOTA	AL DECOM	EICO				
_			ML NECUM			E DECOME	G	
	OTV REQUII							
₩ NO!	APPLICABLE	•			A HRS PER RI			
				EA	A CREW SIZE			
DEACTIV	ATION/REMO	VAL			-			
DATE(S)_		INT. HRS		EVA HRS_		VA CREW		
_				-		-		
⊠ not	APPLICABLE	•						
6. NOTES (B	RIEFLY DESC	RIBE TASKS I	N 1 THROL	JGH 5 ABO	/E)			
(07 spa fro how	V or equ acecraft om LEO in vever a s	ivalent) until read to escape	using dy for d trajec to-gro	RMS or mating. tory. I	equivale Involve No statio Iink is	nt.Stati ment end n resour	h upper stage on could store s with launch ces are require d for checkout	∍d,

TOTAL EVA HRS ___ 0___

①

Code: GDCD 0109

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Mars Lander

Reference Documents:

1. Solar System Exploration Committee Recommended Core Program, Nov 1982

2. NASA Lunar and Planetary Mission Handbook, Volume IV, May 1979

Narrative:

This is a recommended mission in the Ref l program. Launch opportunities to Mars occur approximately yearly (Ref 2, Section MSR). The 1997 launch date is therefore somewhat arbitrary. It was selected late in the decade since two Mars orbiters were scheduled in the 1992 time frame.

- 1	Page 1 of 3
Saturn Probe 6 0 0 1 1 0	TYPE
n MZ 21-9530 nvair Division	Applications (non-commercial)
San Diego, CA 92138	- Commercial
Telephone (619) 277-8900, Ext. 3778/2130	- Technology
Operational Department Approved Scandidate	Operations
1007	Type Number 2
ght, yr ights of Flight	Importance of the Space Station to
IVE ne temperature the atmosphere	this Element 1 - low value
clouds. Characterize the upper atmosphere and the ionosphere.	. 61
	Scale 1 - 10 5
DESCRIPTION This mission will augment the Saturn orbiter in providing detail in-situ measurements of the Saturn system. The probe will complete the picture of the structure and dynamics of Saturn's atmosphere down to a very low altitude.	in-situ measurements of the ture and dynamics of Saturn's

CO.					· · · · · · · · · · · · · · · · · · ·
CODE G.D.O. 1 O Pege 2 of 3	Perigee, km LEO Tolerance + 28.5 Ephemeris Accuracy, m		ac erating andby U	MUNICATIONS ng requirements! Realtime Of Uption/Decryption Requir nk Req.: Command Rate (K) oard Data Processing Req	Data Types: Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

CODE G.D.C.D.O.I.I.O.
□ Passive
deg C operational min
Heat Rejection, w operational min
EQUIPMENT PHYSICAL CHARACTERISTICS
E'1
, kg 2170
IRERENTS
Craw Size 2 Task Assignment
LEVEL 3 2
4
EUR DYES X NO Reason Hra/FUA
Cons
Man Hours
35, kgReturnel
ıctions
Station involvement with Spacecraft ends with launch from LEO into escape trajectory. A ground data link is required for prelaunch checkout. No communication required after launch. No

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GE	OCO CODE	0110	ELEME	NT NAME	SATI	JRN PROBE	· 		
A	COMODA	TION:	ATTACHED	I FRE	E FLYER	⊠ 0TV 0I	PS		
1.	STATION	ACTIVAT	TION (E.G., SET-UP/	ASSEMBLY	/ATTACHM	ENT AND CH	ECKOUT)		
	DATE(S)	1997	INT. HRS	····	EVA HRS_		EVA CREW		
	□ WO.	T APPLICA			. •	·	-		
2.	SERVICE	(E.G., RE	PLENISH/RESUPPL	Y)					
	INTERVA	۱۱	DAYS TOTA	LSERVICE	s	_			
	☐ TM	S/OTV RE	QUIRED	_	ST	ATION HRS P	ER SERVICE		
	⊠ NO	T APPLICA	ABLE		EV	A HRS PER S	ERVICE		
					EV	A CREW SIZE	Ī		
-	8	HRS PE HRS PE T APPLICA			FOR MONIT	OR, INSPECT	r, ETC.)		
♣.			DAYS TOT	AI RECONI	FIGS.				
	_	S/OTV RE	_				ER RECONFI	G	
	_	T APPLICA							
						A CREW SIZE			
5.	DEACTIV	/ATION/R	EMOVAL						
	DATE(S)		INT. HRS		EVA HRS _		EVA CREW		
	. ⊠ NO	T APPLICA	ABLE		-				
6.	NOTES (BRIEFLY	DESCRIBE TASKS I	N 1 THROU	IGH 5 ABOV	/E)			
	(0 sp fr ho	TV or e acecra om LEO wever a	involvement equivalent) ft until rea into escape a spacecraft required (4	using dy for d traject -to-grou	RMS or mating. tory. N und data	equivale Involve lo statio link is	nt.Stati ment end n resour	on could sto s with launce ces are requ	ore ch wired,

TOTAL EVA HRS _____0

Code: GDCD 0110

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Saturn Probe

Reference Documents:

1. Solar System E. ploration Committee Recommended Core Program, Nov 1982

Narrative:

This is a recommended mission in the Ref (1) program.

- 1	- 1		Page 1 of
Comet T2 Rendezvous	ELEMENT NAME endezvous	CODE 6 0 C 0 0 1 2 1	TYPE
CONTACT Name Address	W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division P.O. Box 85357		Applications (non-commercial)
			-Commercial
Telephone	(619) 277-8900, Ext. 3778/2130		Tachnology Development
STATUS	US Operational Planned	pe	Operations
ממארז	Oved Candidate Opportunity	date tunity	Type Number
First flight, yr- No. of flights Duration of Fligh	1992 1 days 1		Table A)
OBJECTIVE	1		this Element
Characterize on-board ins	Characterize the comet's nucleus, coma, and dust with Spacecraft on-board instrumentation.		1 - low value but could use 10 - vital
			Scale 1 - 10 5
DESCRIPTION	-		
The opportunity to re represents one of the A rendezvous with TEM standing solar system	The opportunity to rendezvous with a comet, an encounter with zero relative velocity, represents one of the most exciting challenges ever to the unmanned space exploration program. A rendezvous with TEMPEL 2 should provide one of the most significant steps toward understanding solar system origin and evolution since the first examination of lunar material.	n encounter with zero s ever to the unmanne of the most signific nce the first examina	o relative velocity, ed space exploration program. cant steps toward under- ation of lunar material.

m		, , , , , , , , , , , , , , , , , , , 		
CODE 6.0.0.0.1.2.1 Page 2 of	ORBIT CHARACTERISTICS Apogee, km LEO Tolerance + Inclination, deg 28.5 Geometrice + Nodal Angle, deg Ephemeris Accuracy, m Escape do Regulred.m/s	7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	 MUNICATIONS ng requirements: Realtime Of uption/Dacryption Requirent Req.:Command Rate (K) oard Data Processing Requirent	Data Types: Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

10 40 4 Mark 11 4 754 A

CODE G.D.C.D.O.1.2 1
र्ज । । । ।
EQUIPMENT PHYSICAL CHARACTERISTICS Location! Internal External Remote Equipment ID/Function Pressurized William Him Stowed Lim William Him Deployed Launch mass, kg Consumables Types Acceleration sensitivity, g min
Task Assignment
SERVICING/MAINTENANCE SERVICE: Interval, days Consumables, kg
Ny ka
tions ith launch from LEO into escape traject ut. No communication required after la
servicing required.

Volume II, Book 1 Appendix I

G	DCD CODE U121 ELEMENT NAME COME	T T2 RENDEZVOUS
A	CCOMODATION: ATTACHED X FREE FLYE	R 🖸 OTV OPS
1.	. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTAC	HMENT AND CHECKOUT)
	DATE(S) 1992 INT. HRS EVA H	RSEVA CREW
	□ NOT APPLICABLE	
2.	. SERVICE (E.G., REPLENISH/RESUPPLY)	
	INTERVAL DAYS TOTAL SERVICES	
	TMS/OTV REQUIRED	STATION HRS PER SERVICE
	☑ NOT APPLICABLE	EVA HRS PER SERVICE
		EVA CREW SIZE
3.	. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MO	NITOR, INSPECT, ETC.)
	8 HRS PER DAY (INTERNAL)	
	HRS PER DAY (EVA)	·
	☐ NOT APPLICABLE	
4.	. RECONFIGURATION	
	INTERVAL DAYS TGTAL RECONFIGS	
	TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
	○ NOT APPLICABLE	EVA HRS PER RECONFIG.
		EVA CREW SIZE
5.	. DEACTIVATION/REMOVAL	·
	DATE(S) INT. HRS EVA HR	S EVA CREW
	☑ NOT APPLICABLE	
6.	. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 A	30VE)
	(OTV or equivalent) using RMS spacecraft until ready for matification LEO into escape trajectory	ng of spacecraft with upper stage or equivalent. Station could store ing. Involvement ends with launch v. No station resources are required, data link is required for checkout.

TOTAL EVA HRS 0

40 to 40 to 10 to 724 to 1

Code: GDCD 0121

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Comet Tempel 2 Rendez.ous

Reference Documents:

 MSFC Letter, D. Saxton to Boeing and GDC, "Planetary Mission Requirements for OTV." 7/30/79

- 2. S.A.I. Report No. SAI 1-120-340-T19, Sept 1982; Telecon, J. Niehoff, Oct 1982
- 3. Solar System Exploration Committee Recommended Core Program, Nov 1982
- 4. NASA Lunar and Planetary Mission Handbook, Volume IV, May 1979

Narrative:

A Comet Rendezvous is one of the missions recommended in the Ref (3) program. Tempel 2 was selected because of the existence of a good launch opportunity during the 1990s and the availability of a good mission analysis in Ref (2). Objectives and description are based on material in Ref (4). The mission is also included in Ref (1).

	Page 1 of 3
ELEMENT NAME	TYPE
Main-Belt Asteroid Rendezvous	2.2 KISCIONER L
	Applications (non-commercial)
Hadrass P.O. Box 85357 San Diego, CA 92138	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	- Technology Development
STATUS	Operations
- Approved - Candidate	Tube Number
1992	_
Duration of Flight, days 1	Space Station to
To rendezvous with a Main Belt asteroid and conduct scientific investigations of it and its surrounding region.	could use
	Scale 1 - 10 5
Main Belt asteroids are believed to have remained relatively unchanged since their formation in the primordial Solar System. Examination of these objects from near distances is expected to yield excellent information on composition, morphology, structure, and bulk properties. Such new data may indicate the mode(s) of asteroidal accretion and also yield information on the composition of the solar nebula from which the planets condensed.	to have remained relatively unchanged since their formation Examination of these objects from near distances is expected composition, morphology, structure, and bulk properties. Inde(s) of asteroidal accretion and also yield information on the from which the planets condensed.

G D C D D 1, 2, 2 Page 2 of 3
RBIT CHARACTERISTICS poges, km LEO Periges, km LEO Tolerance + nclination, deg 28.5 seans Ephemeris Acc
OINTING/ORIENTATION JIGH direction Incrtial Solar Earth Fruth Sites (if known) Jointing accuracy, arc sec
OUER C
ATA/COMMUNICATIONS On toring requirements; KNone Encryption/Decryption Requirement Requirement Requirement Requirement Reterment Reter
Data Types: Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

	6	T		-
2.2	Page 3	Stowed Deployed	Roq. Roq. trajectory. A ground fter launch. No	
CODE	X X X X X X X X X X X X X X X X X X X	rizod m 2700	kg Returnel Returnel required a	
	# in	Remote H.	Task Assignment 7 7 7 7 7 7 8 9 9 9 9 9 9 9 9 9 9 9 9	
	ational ational ational	CHARACTERISTICS nat Externat lon Pressurize L,n. U,m Launch mass, kg Consumables Types	2 Task As B) SKILL LEVEL Hrs/Day NCE Hrs/Day NCE Hrs/Day Soliverables, kg Doliverables, kg IONS/See Instructions Spacecraft ends with laufor prelaunch checkout. No	
	eg C non-	PHYSICAL CHAR [] Internal ID/Function L,n. L,n. L,m. Laun	CREW REQUIREMENTS Crew Size Skills (See Table B) EUA	
	THERMAL —Active Temperature, de Heat Rejection,	EQUIPMENT P Location: Equipment]	CREU REQUIREMENTS Crew Size Skills (See Table Skills (See Table CONFICING/MAINTENA SERVICING/MAINTENA SERVICING/MAINTENA SERVICING/MAINTENA SERVICING/MAINTENA SPECIAL CONSIDERAT Station involvement wid data link is required servicing required.	

D

Volume II, Book 1 Appendix I

GI	CD CODE	0122		ELEMENT	NAME MAIN	-BELT A	ASTEROI	D RENDE	ZVOUS	
Α(COMODAT	TION:	☐ ATTAI	CHED	T FREE FLY	ER 🖸	OTV OPS			
1.			•		SEMBLY/ATTA					
	DATE(S)_	1992	INT.	HRS	EVA	HRS	E	VA CREW		
										
	□ NOT	APPLICA	BLE							
2.	SERVICE	(E.G., REP	LENISH/R	ESUPPLY)						
	INTERVA	L	DAYS	TOTAL S	ERVICES					
	☐ TMS	VOTV REC	UIRED		_	STATIO	N HRS PER	SERVICE		
	X NOT	APPLICA	BLE _		_	EVA HR	S PER SER	VICE		
						EVA CR	EW SIZE			
3.	STATION	OPERATIO	ONAL SUP	PORT (AV	S. TIME FOR M	ONITOR, I	INSPECT, E	ETC.)		
	8	_ HRS PER	DAY (IN	TERNAL)						
		– _HRS PER	DAY (EV	A)						
	_	 APPLICA							•	
4.	RECONFI	GURATIO	¥							
	INTERVA	L	DAYS	TOTAL	RECONFIGS.		_			
	☐ TMS	OTV REQ	UIRED			STATION	HRS PER	RECONFI	G	
	⊠ NOT	APPLICA	BLE			EVA HRS	S PER REC	ONFIG.		
						EVA CRE	EW SIZE		 :	
5.	DEACTIVA	ATION/RE	MOVAL							
	DATE(S)_		INT. F	IRS	EVA H	RS	EV	A CREW _		
	_							_		
	□ NOT	APPLICA	BLE							
6.	NOTES (B	RIEFLY D	ESCRIBE 1	TASKS IN 1	THROUGH 5	ABOVE)				
3.	(OTV of space of from Line however	or equi craft u .EO int er a sp	valent; ntil re o escap acecraí) usineady for be traje ft-to-g	ng RMS or r mating. ectory.	equiva Invol No stat a link	lent.St vement ion res is requ	cation ends w sources	pper stage could store ith launch are requienr checkou	e red.

TOTAL EVA HRS 0

Code: GDCD 0122

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Main-Belt Asteroid Rendzvous

Reference Documents:

1. JPL Internal Memo, A.Y. Nakata, "Mariner Mark II Preliminary Mission Requirements Report,: Rev. 2, 10/1/82; GDC Visit, Oct 1982

2. Solar System Exploration Committee Recommended Core Program, Nov 1982

Narrative:

This is a recommended mission in the Ref (2) program. Objectives and description are based on material in Ref (1).

		Page 1 of 3
PAYLOAD ELEMENT NAME Comet HMP Sample Return	CODE G D C D 0 1 2 3	
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division		Applications (non-commercial)
San Diego, CA 92138	,	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	,	Tachnology Development
<u> </u>	pou	Operations
☐Approved ☐Candidate ☐Opportuni	Candidate Opportunity	Type Number 2
First flight, yr 1994 No. of flights 1 Duration of Flight, days 2		(see Table A) Importance of the Space Station to
To obtain samples of volatile and nonvolatile constituents of the comet during a fast fly-through and return them to Earth for analysis.	e constituents of irn them to Earth	
		Scale 1 - 10 5
A comet sample is likely to be the most primitive sample of extraterrestrial material we can study in the foreseeable future. Comets exude an atmosphere of volatile compounds which indicate a low parent body temperature. Information regarding the primitive materials is presumably "frozen-in" in the constituents of comets and their relationship to one another. No othobject in the solar system is likely to be a source of the type of information contained in the comets. HMP is one of several candidate comets suitable for the sample return mission.	nitive sample of extra ide an atmosphere of v ition regarding the pr its and their relation i source of the type o ets suitable for the	ikely to be the most primitive sample of extraterrestrial material we can sable future. Comets exude an atmosphere of volatile compounds which indiody temperature. Information regarding the primitive materials is presumthe constituents of comets and their relationship to one another. No other system is likely to be a source of the type of information contained in the of several candidate comets suitable for the sample return mission.

		•			
Sado, km LEO Tolerance + Tolerance + Tolerance + Ephemeris Accuracy, m	Inertial . Solar Earth c sec Field of view, deg		Requis	g1t8	(BPS) Downlink Fraguancy (MHZ)
STI	1 X 33	UER Gerating Standby Peak	TA/COMMUNICATIONS Intering requirement None Encryption/Decrypt Uplink Req.:Commanulphon-Board Data Proc	Data Types! APIM (Amount) Live TU (Hrs/Day) On-Board Storage (Data Dump Frequence	ording Ra
	Periges, km LEO Tolerance + Z8.5 Ephemeris Accuracy,	STICS Perigee, km LEO Tolerance + 28.5 28.5 Tolerance + Ephemeria Accuracy, m Entition Field of view, deg ty (Jitter)arc sec/sec	BIT CHARACTERISTICS oges, km	Periges, km Tolerance + 28.5 Periges, km Tolerance + Ephemeris Accuracy, m Ephemeris Accuracy, m TION Inertial Solar Earth known) y,arc sec to (Jitter)arc sec/sec tons (Avoidance) Ions (Avoidance) Frequency, Hz Frequency, Hz Realtime Offline Other Command Rate (KBS) a Processing Required	Periges, km LEO Tolerance + 28.5 Periges, km Tolerance + Ephemeris Accuracy, m Inortial Solar Earth frown) Jarc sec Ly (Jitter)arc sec/sec Lons (Avoidance) Chos (Avoidance) Frequency, Hz Chos (Avoidance)

ゅうかい かんり かかべん

	G.D.C.D.O.1.2.3. Page 3 of	•
THERMAL ———————————————————————————————————)
EQUIPMENT PHYSICAL CHARACTERISTICS Location: Ordernal External Remote Equipment ID/Function Ordersurized Unpressurized Lon Un Un Un Hom Lon Un Un Hom Launch mass, kg Consumables Types Acceleration sensitivitu, g min	Stowed Deployed	
Task Assignment		
se Table B) SKILL LEVEL Hrs/Da		
EUA SYES NO Rouson Retrieve Sample Hrs	4	
Consumables,		
GESiInterval, day Deliverables, kg	Man/Hrs Rog.	
ecraft (1 day) ay). Spacecraf	trieval of sample Ind data link required	

me at the second of the second

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION Volume II, Book 1 Appendix I

GDCD CODE U123 ELEMENT NAME COM	ET HMP SAMPLE RETURN
ACCOMODATION: ATTACHED X FREE FLY	ER ☑ OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	
DATE(S) 1994 INT. HRS EVA	HRS EVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	-
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR N	IONITOR, INSPECT, ETC.)
8 HRS PER DA / (INTERNAL)	
HRS PER DAY (EVA)	•
□ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONFIGS.	
☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
E TOTAL EIGHDEE	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	4
DATE(S) 1998 INT. HRS. 8 EVA H	IRS4 EVA CREW1
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	ABOVE)
 Station involvement is for mating (OTV or equvivalent) using RMS (of spacecraft with upper stage
spacecraft until ready for mating.	. Involvement ends with launch
however a spacecraft-to-ground dat	No station resources are required, ta link is required for checkout.
Two men required (4 hours each) for 5. Inspection/packaging of sample for	r 1 day.
INSUME FIGURATERACTION OF SAMOLA TO	ricarin return (one time)

TOTAL EVA HRS 4

Code: GDCD 0123

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Comet HMP Sample Return

Reference Documents:

 Paper, Astronautics and Aeronautics Journal, Jesse W. Moore (NASA), "Effective Planetary Exploration at Low Cost," Oct 1982

- 2. JPL Internal Memo, A.Y. Nakata, "Mariner Mark II Preliminary Mission Requirements Report,: Rev. 2, 10/1/82; GDC Visit, Oct 1982
- 3. Solar System Exploration Committee Recommended Core Program, Nov 1962
- 4. NASA Lunar and Planetary Mission Handbook, Volume IV, May 1979

Narrative:

This is a recommended mission in the Ref (3) program. Objectives and description are based on material in Ref (2), Section 2.3 and Table 4.2-4, and Ref (4). Section CSR. The mission is also included in Ref (1).

		Page 1 of
PAYLOAD ELEMENT NAME Near Earth Asteroid Rendezvous	CODE G D C D O 1 2 4	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division		(hon-commercial)
Hadrass P.O. Box 85357 San Diego, CA 92138		- Commercial
Telephone (619). 277-8900, Ext. 3778/2130		Technology
STATUS		
nai	pou	Operations
	Scandidate □Opportunity	
First flight, yr 1997 No. of flights 1 Duration of Flight days 1		(see Table A) Importance of the Space Station to
OBJECTIVE		this Elomant
To conduct remote sensing of a near-Earth asteroid while in its neighborhood over a period of several months to determine its physical, morphological, and mineralogical characteristics.	steroid while in its s to determine its characteristics.	1 - low value but could use 10 - vital
•		Scale 1 - 10 5
orbit the Sun in modestly inclined and eccentric orbits between the orbits of Earth and Jupiter concentrated between 2 and 4 AU. Asteroids may be remnants of a planet that failed to accrete in the belt; unlike comets, they probably orbit at roughly the distance from the Sun at which	a population of bodies, 1000 km diameter and smaller, ed and eccentric orbits between the orbits of Earth and Asteroids may be remnants of a planet that failed to probably orbit at roughly the distance from the Sun at	diameter and smaller, that he orbits of Earth and Jupiter, planet that failed to accrete stance from the Sun at which
maining istory alf-bil	y altered remnants from original orbits, the and evolution.	population of minimally altered remnants from the accretional phase of still in roughly their original orbits, the asteroids offer unique clues lion years of planetary evolution.

m			1 1 1				
GODE GOCDO124 Page 2 of	ORBIT CHARACTERISTICS Apogee, km LEO Tolerance + Inclination, deg 28.5 Nodal Angle, deg Escape dV Required.m/s 4120	OINTING/ORIENTATION 19w direction Inertial Solar Earth ruth Sites (If known)	Pointing accuracy, are sec Field of view, deg Pointing Stability (Jitter) are sec/sec Special Restrictions (Avoidance)	OUER Ac Dower, W Duration, hrs/day	Standby LContinuous Peak Voltage, U Frequency, Hz	UNICATIONS g requirements! Realtime Of ption/Decryption Requir Req : Command Rate (Ki and Data Processing Req	Data Types: Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

CODE 6.0.0.1.24 B. 2.5.2
Temperature, deg C operational minmmx
non-operational min
nest Adjection, w operational min
PHYSICAL CHARACTERISTICS
rna l
ID/runction [Pressurized Unpressurized
Description
-
CREIL DECLITOCHENTS HCCOloration sensitivity, g min max
s (See Table b) SKILL
LEVEL 3 2
Hrs/Day 4 4
EUA TYES X NO Reason
SERVICE: Interval, days Consumables, kg
Man Hours
Doliverables, kgReturnel
lons
Station involvement with Spacecraft ends with Jaunch from LEO into escape trajectory A ground
Servicing required.

1. 18. 11. 11 11. 12. 14.

Volume II, Book 1
Appendix I

GDCD CODE 0124	ELEMENT NAME	NEAR EARTH	ASTEROID RE	NDEZVOUS
ACCOMODATION: ATTA	CHED FREE	FLYER 🖾	OTV OPS	
1. STATION ACTIVATION (E.G.,	SET-UP/ASSEMBLY/	ATTACHMENT A	ND CHECKOUT)	
DATE(S) 1997 INT.	HRS	VA HRS	EVA CREV	Y
□ NOT APPLICABLE				
2. SERVICE (E.G., REPLEMISH/	RESUPPLY)			
INTERVAL DAYS	TOTAL SERVICES			
TMS/OTV REQUIRED_	<u>,</u>	STATION	HRS PER SERVIC	E
🖸 NOT APPLICABLE _		EVA HRS	PER SERVICE	
		EVA CRE	W SIZE	
3. STATION OPERATIONAL SU	PPORT (AVG. TIME F	OR MONITOR, IN	ISPECT, ETC.)	
8 HRS PER DAY (IN	ITERNAL)			
HRS PER DAY (E	VA)			
☐ NOT APPLICABLE				
4. RECONFIGURATION				
INTERVAL DAYS	TOTAL RECONF	IGS	•	
TMS/OTV REQUIRED		STATION	HRS PER RECONF	IG
☑ NOT APPLICABLE		EVA HRS	FER RECONFIG.	
		EVA CREV	V SIZE	
5. DEACTIVATION/REMOVAL				
DATE(S) INT.	HRS	EVA HRS	EVA CREW	
■ NOT APPLICABLE				
6. NOTES (BRIEFLY DESCRIBE	TASKS IN 1 THROU	GH 5 ABOVE)		

3. Station involvement is for mating of spacecraft with upper stage (OTV or equivalent) using RMS or equivalent. Station could store spacecraft until ready for mating. Involvement ends with launch from LEO into escape trajectory. No station resources are required, however a spacecraft-to-ground data link is required for checkout. Two men required (4 hours each) for 1 day.

TOTAL EVA HRS _____

3

Code: GDCD 0124

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Near Earth Asteroid Rendezvous

Reference Documents:

 Paper, Astronautics and Aeronautics Journal, Jesse W. Moore (NASA), "Effective Planetary Exploration at Low Cost," Oct 1982

- 2. S.A.I. Report No. SAI 1-120-340-T19, Sept 1982; Telecon, J. Niehoff, Oct 1982
- 3. MSFC, Solar System Exploration Scenario, Sept 1982; GDC Visit, Oct 1982
- 4. JPL Internal Memo, A.Y. Nakata, "Mariner Mark II Preliminary Mission Requirements Report,: Rev. 2, 10/1/82; GDC Visit, Oct 1982
- 5. Solar System Exploration Committee Recommended Core Program, Nov 1982
- 6. NASA Lunar and Planetary Mission Handbook, Volume IV, May 1979

Narrative:

This is a recommended mission in the Ref (5) program. Objectives and description were obtained from Ref (6), Section AMR. Ref 1, 2, 3, and 4 include this mission.

Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launched from the shuttle with existing upper stage vehicles. However the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

PAYLOAD ELEMENT NAME	CODE 6 0 C 0 0 1 5 1	TYPE
Det & mon of Episodic Events	1,51,01	X Science &
W. Hardy/ General D		Applications (non-commercial)
Addross P.O. Box 85357 San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Tachnology Development
STATUS	pout	Operations
	Candidate Opportunity	Type Number 2
First flight, yr 1998 No. of flights 1825		Importance of the
3		
Monitoring of areas with high susceptibility to crustal hazards (earthquakes, volcanic eruptions, iandslides), monitoring meteorological events (tornado prone fronts or large storm buildups), and oceanological events (tsunamis and iceberg concentrations).	to crustal hazards), monitoring meteor- ge storm buildups), erg concentrations).	1 - low value but could use 10 - vitai
		Scale 1 - 10 9
DESCRIPTION		
For the detection and monitoring of episodic events the payload will consist of the following instruments for Earth viewing: Multiband Imaging Spectrometer, Multiband Thermal IR Imager, Synthetic Aperture Radar, Passive Microwave Radiometer, Scanning Laser Altimeter, Laser Fluorometer. A boresighted optical system with many sensors slaved to it, and on-board capability of changing spectral and spatial resolution of the instruments is included. Support elements include real time on-board processing and display simultaneously with down link, direct communication link between on-board crew and ground support elements. Capable of on-orbit instrument selection.	events the payload winging Spectrometer, Mul Radiometer, Scanning L by sensors slaved to it the instruments is incolar lay simultaneously wit support elements. Ca	I monitoring of episodic events the payload will consist of the following I viewing: Multiband Imaging Spectrometer, Multiband Thermal IR Imager, idar, Passive Microwave Radiometer, Scanning Laser Altimeter, Laser Fluoro-optical system with many sensors slaved to it, and on-board capability of spatial resolution of the instruments is included. Support elements insard processing and display simultaneously with down link, direct communicated are and ground support elements. Capable of on-orbit instrument

SHARACTERISTICS B, km 450 Periges, km 450 Tolerance	Angle, deg dU Require ING/ORIENTAT	ses (If) accuracy Stabilit]AC Operating Standby Peak	MUNICATIONS ng requirements: Realtime	Description For Display Data Types: XAnalog
. 0 2	Rodal Ar		SER OF	DATA/COM Mond tori	DOST PROPERTY OF STATES OF

3

GD C D D 1 5 1 Frue 3 of 3
S Remote ixed Unpressurized im 10 H, m 3 im 3500 ges Cryogens
CREU REQUIREMENTS
ls (See Table B) SKILL 4 4
Hrs/Day 0.5 0.5
EUA EVES No Rouson Sensor Changeout Hrs/EUA 16
MAINTENANCE 365 Consumables,
ANGESiInterval, day 700 Jan/ Deliverables, kgRetu
ork into coocific outito
cation between the crew, scientist, and possibly civil authorities.

GDCD CODE 0151 ELEMENT NAME DI	<u>ETECTION AND MONITOR OF EPISODI</u>	C E
CCOMODATION: 🖎 ATTACHED 🗆 FREE F	LYER COTV OPS	
. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/AT	TTACHMENT AND CHECKOUT)	
DATE(S) 1998 INT. HRS EV	A HRS EVA CHEW	
		-
☐ NOT APPLICABLE		
. SERVICE (E.G., REPLENISH/RESUPPLY)		
INTERVAL 365 DAYS TOTAL SERVICES	4	
TWS/OTV REQUIRED	STATION HRS PER SERVICE 2	
□ NOT APPLICABLE	EVA HRS PER SERVICE	-
	EVA CREW SIZE	
STATION OPERATIONAL SUPPORT (AVG. TIME FOI	R MONITOR INSPECT ETC!	
	n mulation, inspect, etc./	
1.0 HRS PER DAY (INTERNAL)		
HRS PER DAY (EVA)		
☐ NOT APPLICABLE		
RECONFIGURATION		
INTERVAL 700 DAYS TOTAL RECONFIG	s2	
☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIG. 4	
☐ NOT APPLICABLE	EVA HRS PER RECONFIG. 4	
	EVA CREW SIZE	
. DEACTIVATION/REMOVAL .		
DATE(S) INT. HRS EV/	A HRS EVA CREW	
☑ NOT APPLICABLE		
5. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH	5 ABOVE)	
. Assume resupply cryogenics		
 Assume ground provides alert to software provides cues to events 	on-poard crew, and/or on-board	
Sensor reconfiguration	•	
 Payload operations continue after 	er year 2000	

Code: GDCD 0151

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Detection Monitoring of Episodic Events

Reference Documents:

- 1. Space Station NAAO Study, Orientation Meeting Handout, NASA Headquarters, 14-15 September 1982
- 2. Space Platform Payload Data, Science and Application Space Plaztform Payload Accommodations Study, SP82-MSFC-2583, March 1982
- 3. Strawman Payload Data for Science and Applications Space Platforms, Final Report, SP80-MSFC-2403, January 1980
- 4. Science and Applications Requirements for Space Station, Draft, Provided 17 November 1982 at Interim Review at NASA Headquarters

Narrative:

The principal feature of this payload is the capability of providing data in near real time as related to hazards attributable to earth crustal events.

The principal data were obtained from Ref (1), p. 79 and verified by Ref 4, p. 68.

The flight date, duration, and crew requirements were estimated by GDC.

The power and dimensions were based on similar equipment data found in Ref 2 and 3.

The payload is attached to the space station.

		Page 1 of
PAYLOAD ELEMENT NAME Geoscience - Crustal Dyn Studies	CODE G D C D 0 1 5 2	•
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division		Applications (non-commercial)
Audrass P.O. Box 85357 San Diego, CA 92128		- Commercial
Telephone (619) 277-8900 Ext. 3778/2130		☐ Tachnology Devalopment
nal	boun	Operations
		Number
First flight, yr 1990 No. of flights 1		(see Table A) Importance of the
Duration of Filght, days 1100 OBJECTIVE Obtain information on the accumulation of strain	1	Space Station to
₩ , ;		1 . low calue but
other processes that determine the Earth's surface, which are necessary to provide a framework for interpreting geodetic meas-	surface, which are reting geodetic meas-	could use 10 - vital
	ysical processes.	Scale 1 - 10 10
DESCRIPTION		
Instrument system on space station consists of NdYAG laser using a 0.2 nanosecond pulse length. The sensor is $1.5 \times 1.5 \times 2.5$ meters and contains an agile pointing mirror. The measurement objective of system is a relative position uncertainty in locations of ground based retroflectors of 1 cm precision or better for separation of reflectors on the order of several thousand km.	of NdYAG laser using antains an agile pointinuncertainty in locationtion of reflectors on t	space station consists of NdYAG laser using a 0.2 nanosecond pulse length. 1.5 × 2.5 meters and contains an agile pointing mirror. The measurement is a relative position uncertainty in locations of ground based retroflecton or better for separation of reflectors on the order of several thousand

CODE 6 0 0 1 5 2 Page 2 of 3	ORBIT CHARACTERISTICS Apogee, km 500 Perigee, km 500 Tolerance + 40 0 0 100 - 200 Inclination, deg 50 Tolerance + 40 0 100 - 100 Nodal Angle, deg Escape dV Regulfred, m/s	NG/ORIENTAT Irection Sites (If k ng accuracy ng Stability	OUER Ac NDC Power, W Duration, hrs/day Operating 500 Power, W Duration, hrs/day Standby Ponk Accountinuous Ponk 28 Frequency, Hz	MMUNICATIONS Ing requirements: Realtime Of Tyption/Decryption Requirent Requirement Requirement Rete (K) Board Data Processing Recription	Data Types: Analog EDigital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) Data Dump Frequency (MRZ)
------------------------------	--	---	--	---	---

CODE 6.0.0.0.1.5.2.	lain 10 max 35 max max max max max max max max	stics ernal Remote saurized Unpressurize U,m 1.5 H,m U,m 1.5 H,m ' kg	densitivity, g win	LL 5 Serect largets/UDServe Data	EL 2 /Day 0.2	on Laser Changeout Hrs/FUA 2	Consumables,	day ka	Jons
	# # # E ~ ~ ~ ~	rics aurized burized U,m kg Ygpes		oo Tablo B) SKILL	Hrs/D	Laser		day les, kg.	17

Volume II, Book 1 Appendix I

GOCO CODE 0152	_ ELEMENT NAME	GEOSCIENCE-CR	USTAL DYNAM	ICS STUDIES
ACCOMODATION: X AT	TACHED	E FLYER * 🔲 OTV	OPS	
1. STATION ACTIVATION (E.	.G., SET-UP/ASSEMBLY	ATTACHMENT AND	CHECKOUT)	
DATE(S) 1990 II	NT. HRS	EVA HRS	EVA CREW	
			 -	
☐ NOT APPLICABLE				
2. SERVICE (E.G., REPLENIS	H/RESUPPLY)			
INTERVAL 550 DAYS	TOTAL SERVICES	s <u>1</u>		
TMS/OTV REQUIRE	<u> </u>	STATION HR	S PER SERVICE _	2
☐ NOT APPLICABLE		EVA HRS PER	SERVICE _	2
		EVA CREW SI	ZE _	
3. STATION OPERATIONAL:	SUPPORT (AVG. TIME	FOR MONITOR, INSPE	CT, ETC.)	
0.2 HRS PER DAY	(INTERNAL)			
HRS PER DAY	(EVA)			
☐ NOT APPLICABLE				
4. RECONFIGURATION				
INTERVAL DAYS	TOTAL RECONS	IGS.		
TMS/OTV REQUIRED		<u></u>	PER RECONFIG.	
☑ NOT APPLICABLE			RECONFIG.	
		EVA CREW SIZ	ZE	
			_	
5. DEACTIVATION/REMOVA	•	5\14 1100	51/4 ABSW	
DATE(S) 1993 IN	T. HRS	EVA HRS	_ EVA CHEW	
□ NOT APPLICABLE			-	
6. NOTES (BRIEFLY DESCRI	BE TASKS IN 1 THROU	GH 5 ABOVE)		
*Free flyer accommo require re-evaluat	dation is an a ion of all requ	lternate mode, uirements.	and if used	i will
 Laser changeout Monitor Station Ops 			·	

TOTAL EVA HRS 2

Code: GDCD 0152

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Geoscience-Crustal Dynamics Studies

Reference Documents:

1. Science and Applications Requirements for Space Station, Draft, Provided 17 November 1982 at Interim Review at NASA Headquarters

Narrative:

The payload is to provide measurements of earth crustal deformation which can provide information on stresses within the earth, the interior rheology, and subsurface structure.

Crustal deformation can be interpreted in terms of tectonic plate motion, strain accumulation and release, and other horizontal and vertical motions. This study will provide data needed for fundamental, theoretical, and computational studies of both earthquakes and other processes that deform the earth's surface, which are necessary to provide a framework for interpreting geodetic measurements and for modeling the underlying physical processes.

The Spaceborne Laser Ranging System consists of a pulsed laser distance measurement system that sequentially measures the distance to a number of retroreflector arrays on the ground. From orbit, the laser measures the range to the corner reflectors on the earth's surface as it passes overhead. The measurements can be stored on the station and, subsequently, relayed to a ground terminal. The measurement objective of the system is a relative position uncertainty in the locations of the reflectors of 1 cm precision or better for separations of reflectors on the order of several thousand kilometers.

The technical requirements were obtained from Ref (1), paragraph 3.1.3.2.2.

The schedule and crew requirements were estimated by GDC.

	Page 1 of 3
FAYLOAD ELEMENT NAME Earth SCI Res-Geophysical Inv G D C D O 1 6 1	•
terson MZ 21-9530 cs Convair Division	Applications (non-commercial)
San Diego, CA 92138	
Telephone (619) 277-8900, Ext. 3778/2130	Technology Develorment
nal	Operations
☐ Approved ☐ Onportunity	Type Number 2
ght, yr 1998 Ights i of Flight, days 800	(see Table A) Importance of the Space Station to
to map time-variant changes in the Earth's magnetic field and to map crustal magnetic anomalies.	1 - low value but Could use 10 - vital
	Scale 1 - 10 6 .
DESCRIPTION	
Using vector and scalar magnetometers and magnet field gradiometer the time-variant changes in the Earth's magnetic field will be measured at low Earth orbit over the entire globe at intervals of six months. Tethered satellites and 100-meter booms will be used to deploy sensors from the space station.	r the time-variant changes over the entire globe at will be used to deploy

CODE 6.0 0 1 6 1 Page 2 of 3	ORBIT CHARACTERISTICS Acoges, km 400 Periges, km 400 Tolerance + 100 125 Inclination, deg 90 Tolerance + 5 100 5 100 Nodal Angle, deg Ephemeris Accuracy, m ±10 Ephemeris Accuracy, m ±10 Ephemeris Accuracy, m ±10	POINTING/ORIENTATION Usew direction Inertial Solar XEarth Truth Sites (if known) Pointing accuracy, arc sec 1800 Field of view, deg Pointing Stability (Jitter) arc sec/sec Special Restrictions (Avoidance)	a	UNICATIONS grequirements! \textiting \textit{Command Textiting Textiting \textit{\textit{Command Textiting Textiting Textiting Textiting Textiting \textit{\textit{Command Textiting Textiting Textiting Textiting Textiting Textiting Textiting Textiting \textit{\textit{Command Textiting Textiting Textiting Textiting Textiting Textiting Textiting Textiting \textit{\textit{Command Textiting \textit{\textit{Tex	Data Types! Analog SDigital SHre/Day 24 Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) 10,000 Data Dump Frequency (Per Orbit) Recording Rate (KBPS) Downlink Frequency (MHZ)
------------------------------	---	--	----------	--	---

EQUIPMENT PHYSICAL CHARACTERISTICS Location: Internal External Remote Internal Equipment Lim 2 Internal Internal Stowed Internal Inter
SKILL 5 LEVEL 2 Hrs/Day 0.5 Hrs/Day 0.5 Hrs/Day 0.5 Hrs/Eugl 2 Hrs/Day 0.5 Hrs/Eugl 6.5 Any Hrs/Eugl Bollverables, kg Dollverables, kg
Hrs/Day 0.5 Hrs/Day 0.5 CE Consumables, kg Kg EsiInterval, day Deliverables, kg Man/Hrs Req. No/Soe Instructions Satellite and 100-meter normagnetic boom will be required. It he orbit epherimis to plus/minus 10 meters.
CE ays kg EsiInterval, day Deliverables, kg Nan/Hrs Req. ONS/See Instructions atellite and 100-meter normagnetic boom will be required. It be orbit epherimis to plus/minus 10 meters.
Deliverables, kg Returnables, kg ONS/See Instructions
satellite and 100-meter normagnetic boom will be required. It he orbit epherimis to plus/minus 10 meters.

GDCD CODE 0161	ELEMENT NAME _	EARTH	SCIENCE	RESEARCH
ACCOMODATION: X ATT	ACHED	FLYER	□ 0TV 0F	PS .
1. STATION ACTIVATION (E.G.	, SET-UP/ASSEMBLY/	ATTACHME	ENT AND CH	ECKOUT)
DATE(S) 1995 INT	. HRS	EVA HRS_		EVA CREW
		-		
☐ NOT APPLICABLE				
2. SERVICE (E.G., REPLENISH/	RESUPPLY)			
INTERVAL DAYS	TOTAL SERVICES			
TMS/OTV REQUIRED		STA	ATION HAS P	ER SERVICE
NOT APPLICABLE		EV	A HRS PER SI	ERVICE
		EV	A CREW SIZE	
3. STATION OPERATIONAL SU	PPORT (AVG. TIME F	OR MONIT	OR, INSPECT	, ETC.)
0.5 HRS PER DAY (II	NTERNAL)			
HRS PER DAY (E	VA)			
☐ NOT APPLICABLE				
4. RECONFIGURATION				
INTERVAL DAYS	TOTAL RECONFI	IGS		
TMS/OTV REQUIRED	•	STA	TION HRS PE	R RECONFIG.
■ NOT APPLICABLE	-	EVA	HRS PER RE	CONFIG.
		EVA	CREW SIZE	
5. DEACTIVATION/REMOVA:				
DATE(S) 1997 INT	HRSE	VA HRS _		VA CREW
		_		
☐ NOT APPLICABLE				
6. NOTES (BRIEFLY DESCRIBE	TASKS IN 1 THROUG	SH 5 ABOV	E)	
 Station ops plus Monitor, deploy/ Station ops plus 	retrieve satel	lite		

Code: GDCD 0161

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Earth Science Research-Geophysical Investigation

Reference Documents:

1. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982

Narrative:

It is believed that the earth's crustal magnetic anomalies can be inferred from gradients measured at orbital altitudes. The payload will use magnetometer bearing tethered satellite(s).

The payload's principal requirements were obtained from Ref 1.

The crew, orbit altitude, and schedule were estimated by GDC.

Data rate, power, and physical characteristics were estimated based on similarity to equipment listed in Ref 1.

ORIGINAL PAGE 19 OF POOR QUALITY

		Page 1 of 3
PAYLOAD ELEMENT NAME Renewable Resources - E/SCI Res	CODE 6 0 C 0 0 1 7 1	TYPE
W. Hardy General		Applications (non-commercial)
Hadrass P.O. Box 85357 San Diego, CA 92138		
Telephone (619) 277-8900, Ext. 3778/2130		Technology Development
STATUS Operational Operational	pou	Operations
	Scandidate Opportunity	Tupe Number 2
First flight, yr 1996 No. of flights 1 Duration of Flight, days 1825 OBJECTIVE		Importance of the Space Station to this Element
To acquire spectrum wide multiband data of global land areas for renewable Earth, resources research in biomass, hydrology, land could us use and geosciences. The specific objective is to perform vegitation tation sciences research, vegitation resources inventory and monitoring, land cover dynamic research, hydrauliccycle research, Scale 1 - 10	lobal land areas for is, hydrology, land is to perform vegi- es inventory and rauliccycle research,	1 - low value but could use 10 - vital Scale 1 - 10 10
and water resources inventory and monitoring.		
Earth viewing. The instruments are: for vegitation science research, multispectral linear array (MLA) sensor; for vegitation resources inventory and monitoring, imaging radiometer and radar altimeter; for land cover research - imaging radiometer (as above) and synchotic aperture radar; for hydrological research - imaging radiometer (as above), active radar and passive microwave radiometer (radar and microwave radiometer each require 15-m dia antenna); for water resources inventory and monitoring - multichannel passive microwave radiometer (for snow-4-m dia antenna) and encourted to maniful polytical contents in water and snow and encourted contents.	isors are multispectra litation science researchory and monitoring, radiometer (as above) er (as above), active ach require 15-m dia a live microwave radiome	rincipal features of the sensors are multispectral, high spatial resolution and The instruments are: for vegitation science research, multispectral linear array or vegitation resources inventory and monitoring, imaging radiometer and radar, and cover research - imaging radiometer (as above) and synchotic aperture radar; research - imaging radiometer (as above), active radar and passive microwave in and microwave radiometer each require 15-m dia antenna); for water resources onitoring - multichannel passive microwave radiometer (for snow-4-m dia antenna).

CODE 6,0,0,0,1,7,1,	1 Page 3 of 3
10 um	
Heat Rejection, w operational min max	
S Remote TredX Unpressurize	
E E :	Stowed Deployed
Consumables Types Consumables Types Acceleration sensitivity, a min	1 1
Craw Size 2 Task Assignment Monitor/Select Inst/Data	Inst/Data
LEUEL 3 2	
Hrs/Day 0.5 0.5	
EUA X YES NO Reason Resupply Cryo/Reconfig Hrs/EUA	34
days Consumbles, kg	200
NGEStinterual, dan 365 Mar	8
Deliverables, kgReturnal	ka
lons	l
	ooling and
replacement by the crew. For water resources pointing accuracy of U.1 degree and pointing stability is 5 arc-sec. Revisit frequency: 2 to 5 days repeat global coverage. Accurate	na pointing Accurate
a]-1	description)
and all parts may not be included at one time.	

GDCD CODE 0171 ELEMENT NAME REN	EWABLE RESOURCES-FARTH SCIENCES RESOURCES
ACCOMODATION: X ATTACHED FREE FLY	ER [*] 🔲 OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATT	ACHMENT AND CHECKOUT)
DATE(S) 1996 INT. HRS EVA	HRSEVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 180 DAYS TOTAL SERVICES	<u> </u>
TMS/OTV REQUIRED	STATION HRS PER SERVICE2
NOT APPLICABLE	EVA HRS PER SERVICE 2
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR N	IONITOR, INSPECT, ETC.)
1.0 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
O NOT APPLICABLE	
4. RECGNFIGURATION	
INTERVAL 365 DAYS TOTAL RECONFIGS.	4
TMS/OTV REQUIRED	STATION HRS PER RECONFIG4
☐ NOT APPLICABLE	EVA HRS PER RECONFIG. 4
_	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) INT. HRS EVA H	RS EVA CREW
■ NOT APPLICABLE ,	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	ABOVE)
* Free flyer accommodation is an alt require re-evaluation of all requi	
1. Station ops	
 Cryo service 2 men @ 0.5 hours each (average) 	
4. Sensor changeout	
5. Continued past year 2000	

Code: GDCD 0171

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Renewable Resources-Earth Science Research

Reference Documents:

- Space Station NAAO Study, Orientation Meeting Handout NASA Headquarters, 14-15 September 1982
- 2. Science and Applications Requirements for Space Station, Draft, Provided 17 November 1982 at Interim Review at NASA Headquarters

Narrative:

The payload is intended to increase through spectral band measurements, understanding of earth's renewal resources for solution of food and fiber resources problems.

The payload requirements were obtained initially from Ref 1, p. 30 and refined based on Ref 2, (para. 3.1.3.1).

The schedule and crew requirements were estimated by GDC.

Mass Estimates: Renewable Resources - Earth Science Research

			<u>kg</u>	Power
1.	MLA -		300	500
2.	Imaging Radiometer		100	100
3.	Radar Altimeter	J		
4.	SAR -		300	500
5.	Active Radar (15m antenna)		550	500
6.	Passive μ -wave Radiometer (15m antenna)		300	
7.	Multi-channel Passive μ -wave findingeter (4m antenna)		200	500
8.	Multi-spectral sensor		250	

Total: 2,000

PAYLOAD ELEMENT NAME Operational Land Systems 6 D C D 0 1 7 2	,
	M Science &
acT	Applications
General Dynamics Convair Division	(non-commercial)
P.O. Box 89	1
San Diego, CA 92138	Commercial
Talaskas (619) 277-8900, Ext. 3778/2130	Tachnology
1	Dovelopment
Operational Planned	Operations
	2
0001	Section of the sectio
First flight, yr 1990	
Duration of Flight, days 3650	Space Station to
	ب
To acquire multispectral coverage of global land areas for opera-	
tional Earth resources exploration and monitoring using remote	
sensing.	10 - vital
	Scale 1 - 10 9
DESCRIPTION	
Principal features of the sensors are multispectral, high spatial resolution stable platform mounted for precision pointing and near continuous nadir viewing using large antennas up to 20 meters. Typical instruments are imaging radiometer, radar altimeter, synthetic aperture radar, microwave and IR radiometers, and multiband thermal (IR imager). The orbit selection will be such that the ground track will be repeated every 7 to 10 days. This mission will probably be a free flyer and serviced on orbit.	resolution stable platform using large antennas up to imeter, synthetic aperture iger). The orbit selection days. This mission will

CODE 6.0.0.0.1.7.2 Page 2 of 3	Tolerance + 500 0 0 Chemeris Accuracy, m		Duration, hrs/day Continuous Continuous	Other 10 Frequency (MHZ)	Voice (Hrs/Day) Voice (Hrs/Day) Other Other Downlink Frequency (MHZ)
	ORBIT CHARACTERISTICS Apogee, km 500 Perigee, km Inclination, deg 90 Nodal Angle, deg Escape dV Required.m/s	ING/ORIENTA firection Sites (if ing accuracing Stabili	andby 10.	MUNICATIONS ng requirements: \timestable	Data Types: Analog XDigital Hre/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) 10,000,000 Data Dump Frequency (Per Orbit) Recording Rate (KBPS)300,000(compresse@bwnlink Frequency (MHZ)

THERMAL Jactive	CODE . G.D.C.D.O.1.7.2, Page 3 of 3
PHYSICAL CHARACTERISTICS Internal External L,m 30 u,m L,m 20 u,m L,m 20 u,m LEUEL Hrs/Day Task As Torval, days turnables, kg Deliverables, kg Deli	X Passive min 19 max max
Size Size Size Size 15 (See Table B) EUUEL Hrs/Day ICING/MAINTENANCE ICE!Interval, days Returnables, kg Returnables, kg IGURATION CHANGES:Interval, day IGURATION CHANGES:Interval, day Synchronous orbit, AM equatorial crossing. synchronous orbit, AM equatorial crossing. stream).	PHYSICAL CHARACTERISTICS Internal External Remote Internal Pressurized Unpressurized ID/Function Pressurized Unm 30 H, m 3
Table B) SKILL LEVEL Hrs/Day INO Reason Reconfig AINTENANCE Aval, days urnables, kg ON CHANGESIInterval, day Deliverables, kg SIDERATIONS/See Instruction as orbit, AM equatorial crossing. This. Light and EMR contamination f	REQUIREMENTS Task
XIVES ON Robson Reconfiguration of the platforms. Light and EMR contamination of stream).	Table B) SKILL LEVEL Hrs/Day
ICING/MAINTENANCE 730 Returnables, kg Returnables, kg IGURATION CHANGES:Interval, day Deliverables, kg MAINTENAL CONSIDERATIONS/See Instruction synchronous orbit, AM equatorial crossing. le platforms. Light and EMR contamination f stream).	X YES
TIONS/Soo Instruction, AM equatorial crossing. ght and EMR contamination f	JICING/MAINTENANCE 730 Consumables, kg 4 200 JICE: Interval, days Man Hours Man/Hrs Req. TIGURATION CHANGES: Interval, day 730 Man/Hrs Req. Deliverables, kg
	TIONS/Soo Instruction, AM equatorial crossing. ght and EMR contamination f

GOCO CODE 0172 ELEMENT NAME OPER	RATIONAL LAND SYSTEMS	
ACCOMODATION: ATTACHED THE FLY	ER OTV OPS	
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATT	ACHMENT AND CHECKOUT)	
DATE(S) 1990 INT. HRS E'/A	HRSEVA CREW _	
☐ NOT APPLICABLE		
2. SERVICE (E.G., REPLENISH/RESUPPLY)		
INTERVAL 730 DAYS TOTAL SERVICES 4		
TMS/OTV HECCOMBED ALTERNATE	STATION HRS PER SERVICE	2
☐ NOT APPLICABLE	EVA HRS PER SERVICE _	
	EVA CREW SIZE	1
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR M	MONITOR, INSPECT, ETC.)	
HRS PER DAY (INTERNAL)		
HRS PER DAY (EVA)		
☑ NOT APPLICABLE		
4. RECONFIGURATION		
INTERVAL 730 DAYS TOTAL RECONFIGS.	4	
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.	4
☐ NOT APPLICABLE	EVA HRS PER RECONFIG	4
	EVA CREW SIZE	1
5. DEACTIVATION/REMOVAL		
DATE(S) INT. HRS EVA H	ARS EVA CREW	
50. Clar 14		
☑ NOT APPLICABLE		
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	ABOVE)	
This payload element has orbit transf		
2. Cryo Service 4. Change sensors		
5. Free flyer continues past year 20	00	

Code: GDCD 0172

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Operational Land Systems

Reference Documents:

1. Space Station NAAO Study, Orientation Meeting Handout `SA Headquarters, 14-15 September 1982

2. NASA TM-82482, MSFC, April 1982

Narrative:

A free-flyer accommodation was selected primarily due to orbit inclination required in the early time frame. The payload is assumed to provide LANDSAT-type data.

Requirements were derived from Ref 1. The spacecraft includes orbit transfer propulsion.

Service and maintenance requirements and schedule were estimated. The configuration change is assumed to be accomplished by man Ref 2.

Landsat D mass is 1724 kg; Estimate for this advanced version is 2000 kg.

PAYLOAD ELEMENT NAME Shuttle Active Microwave Exp	TYPE
on MZ 21-9530 onvair Division	Applications (non-commercial)
Mddross P.O. Box 85357 San Diego, CA 92138	O Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Technology Development
næl	Operations
☐ Approved ☐ Opportunity	
First flight, yr 1992 No. of flights 1 Duration of Flight, days 730	Importance of the Space Station to
	this Element
Continue development of MASA imaging radar sensors for operational use in spaceborne imaging radars probe for all weather imaging of Earth's land and ocean surfaces.	1 - low value but could use 10 - vital
	Scale 1 - 10 6
DESCRIPTION The Shuttle active microwave experiment (SAMEX-C) for space station will use C-band radar imaging equipment having a synthetic aperture radar with a large antenna using dual polarization, and incidence angles between 15 and 65 degrees. An advanced digital SAR processor (JPL) is a potential having a computational capability of 2.5 billion operations per second.	ation will use C-band radar ge antenna using dual polariza- nced digital SAR processor (JPL) n operations per second.

0 - 0			•		
Page 2 of 3	125 61.5	dir	□ Continuous -		
	9	20 to 75 of madir	Cont	H2)	
6 0 C 0 0 1 7 3	100	20 to 7	_	Fraquency (MHZ)	(ZHW)
CODE C.D	+ + + + + + + + + + + + + + + + + + + +	Dep	Aap	radea) encu
၀၁ ၅	Tolerance ince + iris Accura	XEarth of view,	hrs/		Hra/Day) (Hrs/Day) Other Ak Freque
	Tolerance + Tolerance + Ephemeris Accuracy,	XEarth Field of view.	Duration, hrs/day	Offline Other squired (10 MHz)	
,	Tol. Eph		U Durat	lex wor	tal Voice D
	400			quired quired (KBS) Required 16-bit comp	X Digital U IBD Ibit) D
	s, km	TION Inertial	Power, 5000 300 7500	Coffi Required te (KBS) ng Requi	50
	Periges, km	Inertial Inertial Inertial Inc sec 36((Jitter)	5000 300 7500	userts: emitime [ruption Re- emind Rate Processing	A Analog TBD
	TI.	ATION Known) CU, arc	('- 11		
	CHARACTERIS b, km 400 nation, deg Angle, deg adV Reguire	POINTING/ORIENTATION Use direction Inertial (Truth Sites (if known) Pointing accuracy, arc sec 3600 Pointing Stability (Jitter) arc Special Restrictions (Avoidance	Operating Standbi.	DATA/COMMUNICATION And to the following requirement of the following particular and the following parti	Typest (Amount TU (Hrs. Board Stor
			Open Sten Peak	Monttoring Monttoring Control Encry Mon-Boar	10 t 1 c - t
	ORBIT C Apogee, Inclina Nodal A Escape	POINTING UIGH dire Truth Sit Pointing Pointing Special R	POUER OPER Star		10 K 70 0 K

м]	1		, ,		1
73 Page 3 of	1 111	Stowed Deployed	ite Equipment		2		
CODE 6.0 c.0 0.1	X X X X G G G G G G G G G G G G G G G G	2 po	Checkout/Operate		- Hrazeva		
	10	nal Remote urized Unpressurized U,m 3 H,m U,m 3 H,m kg	Assignment	3 4	y 2 Reconfiguration	Sonsumables, Man Hours	51
	Passive operational min non-operational min operational min non-operationel min non-operationel min min	1. S. S. T.	Task	SKILL LEVEL	Hrs/Day Reason Reconfi		/Soe Instructions
	XPas ag C non-	PHYSICAL CHARACTERIST Internal Extantaction Pressible 15 L, m 15 Launch mass, Consumables Acceleration	} [(able B)	040	INTENANCE -val, days rnablos, kg (CHANGES: Inte	CONSIDERATIONS/Sam
	THERMAL Mactive Temps:ature, deg	EQUIPMENT PHO Location: C Equipment ID.	CREU REQUIREMENTS Craw Siza	Skills (See Table	EUA XYES	SERVICING/MAINTENANCE SERVICE: Interval, days Returnables, kg Returnables, kg CONFIGURATION CHANGES: Interval	SPECIAL CONS

GOCD CODE 0173 ELEMENT NAME	SAMEX-C
ACCOMODATION: ATTACHED	EE FLYER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBL	Y/ATTACHMENT AND CHECKOUT)
DATE(S) 1992 INT. HRS	EVA HRSEVA CREW
	<u> </u>
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS GOTAL SERVICE	ES
TMS/OTV REQUIRED	STATION HRS PER SERVICE
☑ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME	FOR MONITOR, INSPECT, ETC.)
0.2 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
☐ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL 365 DAYS TOTAL RECON	FIGS
☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIG. 2
☐ NOT APPLICABLE	EVA HRS PER RECONFIG. 2
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
	EVA HRS EVA CREW
□ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROU	IGH 5 AROVE)
1. Station ops	, 4, 5, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6,
3. Equip operations (average)	
 EVA and station support of se Station ops 	nsor reconfiguration

Code: GDCD 0173

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Shuttle Active Microwave Experiment (SAMEX-C)

Reference Documents:

- 1. Space Station NAAO Study, Orientation Meeting Handout NASA Headquarters, 14-15 September 1982
- 2. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982
- 3. Strawman Payload Data for Science and Applications Space Platforms, Final Report, SP80-MSFC-2403, January 1980
- 4. Spaceborne Imaging Radar Probe "In-Depth," IEEE Spectrum, November 1982, Elachi & Granger of JPL.

Narrative:

This payload is another step to NASA development of imaging radar. This schedule is shown in Ref 1.

The data were derived from Ref (4) except: a) The physical size and mass which was estimated by GDC based on similar equipment found in Ref 2 and 3, and b) orbit which was given by GDC as preferred for global coverage.

SAMEX-C Mass Estimate

SAR - MSFC/JPL

Radar	800 kg	6000 W.
Integration HW	1,076 kg	486 W.
+ growth:	1,876 kg 124 kg	6486 W.
Total:	2,000 kg	

			Page 1 of
PAYLOAD ELEMENT Earth Obs Instr Dev	ENT NAME Dev - Microwave	CODE G D C D O 1 7 4	
CONTACT W.	W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division		Applications (non-commercial)
	r.u. bux asss/ San Diego, CA 92138		Commercial
Telephone (61	(619) 277-8900, Ext. 3778/2130		Technology Decelonant
STATUS	•		
Operations		☐ Planned ☐ Candidate ☐ Opportunity	Upperations 2
First flight,	r 1991		(see Table A)
No. of flights Duration of Flights	Flight, days 730		Importance of the Space Station to
OBJECTIVE			
Demonstrate sma measurements wi zation such as	Demonstrate smart sensor technology for passive microwave remote measurements with real time target adaptable sensor mode optimization such as resolution cell size are measurement accuracy.	sive microwave remote e sensor mode optimi- surement accuracy.	1 = low calue but Could use
			•
DESCRIPTION			
Passive microwa ment and evalua of geographical speed, rain rat	Passive microwave remote sensing technology payload consisting imaging radiometer for development and evaluation using multibeam and multifrequency techniques. Simultaneous measurement of geographical parameters to be performed are: sea surface temperature, ocean surface wind speed, rain rate, sea ice classification data, atmospheric data, etc.	payload consisting ime tifrequency techniques, are: sea surface temper ta, atmospheric data,	aging radiometer for develop- . Simulcaneous measurement rature, ocean surface wind etc.

Page 2 of 3	61.5		□ Continuous		
6 D C D 0 1 7 4 P	009	±45 nadir		Frequency (MHZ)	(MHZ)
2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Tolerance + 0 Ephemeris Accuracy.	Earth Field of view, deg c	Duration, hrs/day	Other Frequ	Voice (Hrs/Day) Other Other Downlink Frequency (MHZ)
	Toler Ephem	Solar	E	ine	116
	rgee, km	sec 36		ents: ltime ption Req mand Rate	Analog (MBIT) ICH (Per Or (BPS)
	TERISTI 1000 deg deg	ENTATIO	AC Sereting Sak Sak	MMUNICATI Ing requi Cyption/D Ink Req.: Board Dat cription	Types: (Amount) TO (Hrs pard Sto Dump Fr
	ORBIT CI Apoges, Inclina Nodal Ai	POINTING/ORI Ulew directi Truth Sites Pointing ste Special Rest	OUER	Montoring Communications Communications Communications Descriptions	20017 20017 2007 2007 2008

0	G D C D O 1 7 4 Page 3 of
THERMAL []Active X Passive Temperature, deg C operational min 10 10 10 10 10 10 10 1	35
EQUIPMENT PHYSICAL CHARACTERISTICS Location: Internal External Remote Equipment ID/Function Pressurized Unpressurized L,m 1.5 U,m 1.5 W,m 1 H,m L,m 1.5 U,m 1.5 Consumables Tunes	d 1 Stowed 1 Deployed
-	XQE
	Deploy/Checkout/Monitor
Skills (See Table B) SKILL 4 LEVEL 3	
Hrs/Day 0.25	
EUA TYES XNO Reason	Hrs/EUA
Consumables	kg
NGESIInterval, day 365	Man/Hrs Roq.
lons	J
Space station preferred to use main-in-the -loop necessary to develop smart sensor technology in the optimum way and to demonstrate operational feasibility. (This payload could benefit commercial payload GDCD 1000.)	velop smart sensor technology (This payload could benefit

GDCD CODE 0174 ELEMENT NAME EAR	TH OBS INST DEVELOPMENT
ACCOMODATION: X ATTACHED - FREE FLY	ER 🔲 OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	ACHMENT AND CHECKOUT)
DATE(S) 1991 INT. HRS EVA	HRS EVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR M	ONITOR, INSPECT, ETC.)
0.25 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
☐ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL 365 DAYS TOTAL RECONFIGS.	1
☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIG. 4
☐ NOT APPLICABLE	EVA HRS PER RECONFIG.
MOT AFFEIGABLE	EVA CREW SIZE
	EVA GREW SIZE
5. DEACTIVATION/REMOVAL	·
DATE(S) 1993 INT. HRS EVA H	RS EVA CREW
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 A	ABOVE)
 Station ops Deployment of Antenna, c/o, monitor 	0.44
4. Reconfiguration for internal equi	pment only.
5. Station ops	•

Code: GDCD 0174

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name:

Earth Observations Instrument Development

(Microwave Technology)

Reference Documents:

 Space Station NAAO Study, Orientation Meeting Handout NASA Headquarters, 14-15 September 1982

Narrative:

The payload is to develop passive microwave sensors for imaging radiometry related to oceanic surface phenomenon. A technology advancement is postulated.

The payload is based on data contained in Ref 1, attachment A, Technology, page 50.

The crew requirements and schedule are estimates of GDC.

Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 0174 PAY

PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Earch Observation Instrument Langiey Contact: R.F. Harrington

Experiment Title: Microwave Remote Sensing Technology-Passive Systems

Mission Objectives: Demonstration of smart sensor technology for passive microwave remote measurements with real time target adaptable sensor mode optimization such as resolution cell size and measurement accuracy.

Mission Description: A multiple frequency, multiple beam imaging microwave radiometer system would be developed and evaluated in space to measure several geophysical parameters simultaneous. These parameters are soil moisture, sea surface temperature, ocean surface wind speed, rain rate, sea ice classification data, atmospheric data, etc.

Benefit: This mission is needed to develop and demonstrate the technology for future operational earth observational satellites for measurement of many important geophysical parameters using passive techniques.

Justification: The feasibility of geophysical parameter measurements from passive microwave instruments has been demonstrated using satellite radiometers such as ESMR and SMMR. However, additional microwave instrument and algorithm development work is required to bring these measurements from a feasibility demonstration to an optimum operational basis.

Mission Requirements and Capability: Oribt: Altitude 500 to 1500 km

S/C Interface: Weight 200 kgm

Volume 1.5 m³
Power 200 watts

Space Station vs. Free Flyer: Space station preferred to take advantage of man-in-the-loop modes necessary to develop smart sensor technology in the most optimum way.

	Page 1 of 3
PAYLOAD ELEMENT NAME Earth Obs Instr Dev - Visible/RF G D C D 0 1 7 5	
terson MZ 21-9530 cs Convair Division	Applications (non-commercial)
San Diego, CA 92138	
Telephone (619) 277-8900, Ext. 3778/2130	- Technology Development
STATUS Degrational Planned	Operations
	Type Number 2
First flight, yr 1994 No. of flights 1 Duration of Flight, days 730	(see Table A) Importance of the Space Station to
	this Element
To develop instrumentation, which senses various earthbound phenomena, with a wide variety of attributes, i.e, broad RF region and extra visible regions.	1 = low value but could use 10 = vital
	Scale 1 - 10 9
DESCRIPTION Sense Earth-based phenomena outside the current restrictive bands in electromagnetic spectrum (e.g., the visible and relatively narrow RF band). Perform developmental testing and demonstrate operation potential.	rictive bands in electromagnetic spectrum Perform developmental testing and demon-

. . . .

ORIGINAL PAGE IS OF POOR QUALITY

(T) 	7 111			
Page 2 of 3	125 61.5		☐ Continuous		
CODE 6.0 C.0.0.1.7.5.	009 0+ 6:	deg ±45 nadir		Fraquency (MHZ))
<u> </u>	Tolerance + 0 Ephemeris Accuracy,	XEarth Field of view,	Duration, hrs/day	Other Fi	Voice (Hrs/Day) Other Downlink Frequency (MHZ)
	400		L eques	Coffline Required ite (KBS) ng Required	914
	Periges, km	sec ter)		ents: litime jption Req mand Rate	Analog XD1()
	CTERI 400 deg	ORIENTA ction as (if sccurac Stabili	AC perating tandby eak		Data Types: Tilm (Amount) Live TU (Hrs/Day) On-Board Storage Data Dump Frequen
	ORBIT CHARA Apoges, km Inclination Nodal Angle Escape do R	POINTING/ Ulow dire Truth Sit Pointing Pointing Special R	POUER OF SE	Mon toring Mon toring Non toring Non Encryp On-Bost	FILLS CALCE DALE

CODE 6.0.0.1.7.5
operational min 10 max operational min max
Remote Vypressurize
Sonsitivity, g minmax
2
0.25
Reason Cryogens/Reconfig Hrs/EUA
bles,
365 Hours Man
Roturnah
IIUNS/See Instructions ne development process. (This payload could benefit commercial payload

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GDCD CODE 0175 ELEMENT NAME	EARTH OBS INSTRUMENT DEVELOPMENT
ACCOMODATION: ATTACHED FRE	(EXTRA VISIBLE & RF) EFLYER □ OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY	/ATTACHMENT AND CHECKOUT)
DATE(S) 1994 INT. HRS	EVA HRSEVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 365 DAYS TOTAL SERVICE	s <u>1 </u>
TMS/OTV REQUIRED	STATION HRS PER SERVICE 2
NOT APPLICABLE	EVA HRS PER SERVICE 2
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME	FOR MONITOR, INSPECT, ETC.)
0.25 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL 365 DAYS TOTAL RECON	FIGS1
TMS/OTV REQUIRED	STATION HRS PER RECONFIG. 2
☐ NOT APPLICABLE	EVA HRS PER RECONFIG. 2
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
	EVA HRS EVA CREW
DATE(a)INT. FINS.	EVA CHEW
□ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROU	IGH 5 ABOVE)
1. Station ops	
 Resupply cryogenics Routine record and monitoring 	
4. Sensor reconfiguration	
5. Station ops	

TOTAL EVA HRS 4

Page 1 of 1 Volume II, Book 1 Appendix I

Code: GDCD 0175

PAYLOAD ELEIENT SYNTHESIS

Earth Observations Instrument Development (Extra Visible and Broad RF) Payload Element Name:

Reference Documents:

Space Station NAAO Study, Orientation Meeting Handout NASA Headquarters, 14-15 September 1982

Narrative:

This payload (outlined in Ref 1, Attachment A, p. 52) is essentially the same in requirements as GDCD 0174 except this payload concerns broad-band RF sensors and extra-visible region sensors.

		Pags 1 of 3
PAYLOAD ELEMENT NAME	CODE	TYPE
EO Sensor/Technique/Auto Sys Dev	6 0 6 0 0 1 / 6	X Science L
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division		Applications (non-commercial)
Addrass P.U. Box 85357 San Diego, CA 92138		Commercia
Telephone (619) 277-8900, Ext. 3778/2130		Technology
		2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Operational Planned Approved	nod	Operations
1992	Opportunity	Type Number (see Table A)
No. of flights 1 1460 Duration of Flight, days 1460		Importance of the Space Station to
OBJECTIVE		this Element
1. To develop Earth observing instrumentation and observing parameters for use in operational platforms.	on and observing Ths.	-
	hniques.	14210 - 01
 To develop Earth observing techniques for rapidly communicating information to users in near real time. 		Scale 1 - 10 10
DESCRIPTION A manned Earth Observatory will experiment with a variety of prototype Earth observing instrumentation. Studies of candidate spectral and spatial resolution of optimum	l experiment with a v	variety of prototype Earth
Sun elevations and viewing angles and of various polarizations versus particular ground fea-	ous polarizations ver	sus particular ground fea-
tures are examples of technology that could be improved for use on later operational remote	e improved for use or	later operational remote
sensing satellites. Man will play a rolu in orienting instrumants to observe and record phonomena that are transitory in either time or location. By using real-time displays he will	orienting instruments location. By using r	Man will play a role in orienting instruments to observe and record phesitory in either time or location. By using real-time displays he will
select the best instrumentation to record what he was observing. Man will selectively trans- mit appropriate data to the ground for consultation with ground based experss. Man will develo	it he was observing.	rumentation to record what he was observing. Man will selectively trans- to the ground for consultation with ground based expers. Man will develop
techniques for detecting and monitoring episodi	c events, e.g., volcan	ing and monitoring episodic events, e.g., volcanoes, earthquakes, tidalwaves,
and severe storms.	فالمتعدد والمتعدد والمت والمتعد والمتعدد والمتعدد والمتعدد والمتعدد والمتعدد والمتعد	

CODE 6 D C D O 1 7 6 Page 2 of 3	425	±45 nadir	Continuous	Frequency (MHZ)	(MHZ)
3000	ORBIT CHARACTERISTICS Apogeo, km 500 Forigeo, km 500 Tolerance + 0 Inclination, deg Nodal Angle, deg Escape do Required.m/s	OINTING/ORIENTATION ISM direction ruth Sites (if kointing accuracy ointing Stability becial Restricti	OUER Gec Operating Standby Peak	MMUNICATIONS Ing requirements: [X] Realtime X] Offline Other ryption/Decryption Required Ink Req.: Command Rate (KBS) Board Data Processing Required cription	Data Types: Analog XDigital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) 500,000 Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 80,000 Downlink Frequency (MHZ)

	6			11 - 1 - 1			
	3 0 2	Stowed	str & Site Sel.		18		kg rs with image is as indicated fic research
CODE 6 0 C 0 0 1 7 6		×	Assignment Data Interpretation/Instr &	5 2 0 E	1 1	kg 4	Earth viewing, aided by gimballed zoom optical system required. Pointable sensors with image motion compensation. This R&D laboratory is a combination of three basic missions as indicated and observation technique development.
	tional min 10 tional min	rnal Remotsurized Munpre U.m. Kg	Task		ryogens/R	180 day	ONS/Soc Instructions gimballed zoom optical system require R&D laboratory is a combination ill maximize mans capability to enhie development.
٠	.ve X Passive v deg C operations non-operations lon, w operations non-operations non-opera	PHYSICAL CHARACTERISTICS X Internal X External ID/Function X Pressuri L,m U, L,m U, Launch mass, kg	1	(a		AINTENANCE Broal, days urnables, kg N CHANGESIInterval, day	SPECIAL CONSIDERATIONS/Soo Instart viewing, aided by gimballed zoon motion compensation. This R&D laborat under objectives. It will maximize mand observation technique development.
	THERMAL Hactive Temperature, degree Heat Rejection,	EQUIPMENT PI Location: Equipment I	CREU REQUIREMENTS Craw Siza	Skills (See Table	EUA (X) YES	SERVICING/MAINTENANCE SERVICE:Interval, day: Returnables, CONFIGURATION CHANGES	SPECIAL CONSIDERATI Earth viewing, aided by motion compensation. Thunder objectives. It wield observation techniques.

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GDCD CODE 0176 ELEMENT NAME EO	SENSOR/TECHNIQUE/AUTO SYSTEM DEVELOPMENT
ACCOMODATION: X ATTACHED TREE FLY	TER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATT	ACHMENT AND CHECKOUT)
DATE(S) 1992 INT. HRS EVA	HRS EVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 180 DAYS TOTAL SERVICES	7
TMS/OTV REQUIRED	STATION HRS PER SERVICE 2
□ NOT APPLICABLE	EVA HRS PER SERVICE 2
	EVA CREW SIZE 1
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR I	MONITOR, INSPECT, ETC.)
1.0 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	•
NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL 730 DAYS TOTAL RECONFIGS.	1 .
	STATION HRS PER RECONFIG. 4
	EVA HRS PER RECONFIG. 4
	EVA CREW SIZE1
5. DEACTIVATION/REMOVAL	
DATE(S) 1996 INT. HRS EVA	HRS EVA CHEY!
□ NOT APPLICABLE	
	40015
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	ABOVE)
 Station OPS Resupply Cryogenics 	
3. 2 crew men @ 0.5 hours each	
 Interchange arrays, filters and i Station OPS 	nstruments

TOTAL EVA HRS ______

GDC-ASP-83-002

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Code: GDCD 0176

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name:

Earth Observations Sensor/Technique/Anslysis

Automated System Development

Reference Documents:

 Space Station NAAO Study, Orientation Meeting Handout NASA Headquarters, 14-15 September 1982

Narrative:

This payload was initially considered to be three distinct payloads; one to develop instruments, one to develop observing techniques, and a third to use manned earth observations to study remote sensing research with a goal of defining/refining analytical techniques. They are presented separately in Ref 1, attachment A, pp 78, 82, 85.

It is felt however, that the three can be combined (or at least expand) into one payload/mission.

This payload also has a great potential for demonstrating or determining the usefulness of man in space to observe, analyze, and select "next" target.

The requirement parameters are generic and based on such payloads as GDCD 0173, 0174, etc.

The first-flight date (schedule) was chosen based on the necessity of having it started as soon as feasible.

		Page 1 of
IAME	CODE	TVPE
Geoscience - Geology Remote Sens		X 50.1980
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division		
San Diego, CA 92138		- Commercial
Telephone (619) 277-8900, Ext. 3778/2130	3778/2130	Technology Development
STATUS	Planad	Oberations
Approved	X Candidate Opportunity	Tubo Number
First flight, ur 1990		(see Table A)
No. of flights 1 Duration of Flight, days	1800	Importance of the
OBJECTIVE Acquire data on co	data on composition, structure, and chron-	
	visible and infrared imagery and microwave	1 - low value but
_	or near simultaneously to eliminate temporal	could use 10 - vital
cover.		•
		Scale 1 - 10
DESCRIPTION		
The payload consists of many la multipolraization/multiple look spectrometer, thermal IR multis	of many large instruments for Earth viewing, i.e., multifrequency/ tiple look synthetic aperture radar, multispectral programmable imaging IR multispectral scanner, scanning lasar altimeter, polar subsurface	i.e., multifrequency/ ectral programmable imaging timeter, polar subsurface

CORPORATION THE

(F)					
G D C D D 1 7 7 Page 2 of	ORBIT CHARACTERISTICS Apogae, km 500 Forigee, km 500 Tolerance + 100 200 Inclination, deg 90 Tolerance + 10 10 10 Nodal Angle, deg Ephemeris Accuracy, m Ephemeris Accuracy, m	46/ORIENTAT Irection Sites (if king accuracy ng Stabilit	OUER AC ND Operating 10 Standby Peak	MMUNICATIONS Ing requirements: Realtime Of Tyption/Decryption Requirement Requirement Reto (KI Board Data Processing Record Data	Data Types: Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 300,000 Downlink Frequency (MHZ)

ORIGINAL PAGE IS OF POOR QUALITY

6 D C D O 1 7 7 Page 3 2 6 3	35	Ssurized H,m 3 2000	Jask Assignment Instrument Selection/Observe	5	Hrs/Day 0.2 Reason Subsystem Changeout Hrs/File 8	les, kg	kg Returnables kg	, contaminants, particulate, gas
	THERMAL GACTIVE Temperature, deg C non-operationa Heat Rejection, w non-operationa	EQUIPMENT PHYSICAL CHARACTERISTICS Location: Dinternal External Equipment ID/Function Pressurize L,m 30 U,m L,m 30 U,m L,m 30 U,m Launch mass, kg Consumables Types		Skills (See Table B) SKILL LEVEL	0	NCE days	CONFIGURATION CHANGES: Interval, day	SPECIAL CONSIDERATIONS/500 Instructions Ground track repeat cycle: seasonal Major susceptibilities: RFI at radar frequencies sates on optical surfaces, scattered light for st

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GDCD CODE 0177	ELEMENT NAME	GEOSCIE	NCE-GEOLOGY	REMOTE SENSING
ACCOMODATION: X A	TTACHEO - FRI	EE FLYER*	OTV OPS	
1. STATION ACTIVATION (E	.G., SET-UP/ASSEMBL	Y/ATTACHME	NT AND CHECKOL	JT)
DATE(S) 1990 1	NT. HRS	_ EVA HRS _	EVA	CREW
☐ NOT APPLICABLE				
2. SERVICE (E.G., REPLENIS	H/RESUPPLY)			
INTERVAL DAYS	TOTAL SERVICE	ES	-	
TMS/OTV REQUIRE	D	STAT	rion HRS Fer sei	RVICE
☑ NOT APPLICABLE		EVA	HRS PER SERVICE	E
		EVA	CREW S!ZE	
3. STATION OPERATIONAL	SUPPORT (AVG. TIME	FOR MONITO	R, INSPECT, ETC.)	1
0.2 HRS PER DAY	(INTERNAL)			
HRS PER DAY	(EVA)			
☐ NOT APPLICABLE				
4. RECONFIGURATION				
INTERVAL 365 DAYS	TOTAL RECOM	IFIGS A		
☐ TMS/OTV REQUIRE				ONFIG. 2
□ NOT APPLICABLE	•			IG. 2
MINITARIE			CREW SIZE	1
		EVA	JUEN SIEL	
5. DEACTIVATION/REMOVA				
DATE(S) 1995 IF	IT. HRS	EVA HRS	EVA CR	EW
☐ NOT APPLICABLE				
6. NOTES (BRIEFLY DESCRI	BE TASKS IN 1 THRO	UGH 5 ABOVE)	
*Free flyer accommo require re-evaluat	odation is an a tion of all rea	alternate quirements	mode, and i	f used will
 Station OPS Monitor Subsystem changes Station OPS 	geout			

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Code: GDCD 0177

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Geoscience-Geology Remote Sensing

Reference Documents:

1. Science and Applications Requirements for Space Station, Draft, Provided 17 November 1982 at Interim Review at NASA Headquarters

Narrative:

The goal of geology is to acquire sufficient information on composition, structure, and chronology to reconstruct the geologic evolution of an area. Remote sensing is particularly useful for determining structure and lithology. By the advent of the space station in the early 1990s, we will have learned how to use the visible and infrared imagery obtained by Landsat to discriminate and identify rock units and map surface structure. Significant advances in radar remote sensing will have been made toward understanding the effect of variable incidence angles, wavelengths, and polarizations on the interpretability of orbital radar imagery. The next step will be to combine these two types of data in a controlled manner (registered and calibrated) to determine what geological information can be obtained from the combined data sets. The advantage offered by the space station is its capability of supporting many large instruments so that data may be acquired over a particular area simultaneously with all instruments (from Ref 1, para 3.1.3.2.1).

The following measurements will be considered:

<u>Visible and reflected infrared methods obrain measurements of reflected solar radiation at wavelengths of 0.4-2.5 micrometers.</u>

Thermal infrared methods measure emitted thermal radiation, primarily in the 8-14 micrometer region.

Radar imaging techniques measure backscatter microwave radiation at wavelengths of 1-50 cm.

The instrument and mission requirements were also obtained from Ref (1), paragraph 3.1.3.2.1.

GDC-ASP-83-002

Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 0177 PAYLOAD ELEMENT SYNTHES:
--

Geoscience - Geology Mass Estimate

1.	SAR -	300 kg
2.	Imaging Spectrometer	500
3.	Multispectral Scanner	(included in 1)
4.	Scanning laser altimeter	185
5.	Polar Subsurface Sounder	300
6.	Active Fluorescence Spectrometer	300
7.	Luminescence detector	300
	+ Growth	115 kg
		Total: 2,000 kg

ORIGINAL PAGE 13 OF POOR QUALITY

		Page 1 of
PAYLOAD ELEMENT NAME Imaging Radar for ER Inventory	CODE G D C 0 0 1 7 9	TYPE
W. Hardy/. General Dy		Applications (non-commercial)
Addross P.O. Box 85357 San Diego, CA 92138		- Commercial
Telephone (619) 277-8900, Ext. 3778/2130		☐ Technology Develorment
STATUS Degrational	Po	Operations
	date	Number
First flight, yr. 1996 No. of flights 1 Duration of Flight, days 1095		
		this Eloment
Monitor soil moisture distribution, crop classification, snow dynamics, geological maping, etc.	sification, snow	1 = low value but could use 10 = vital
		Scale 1 - 10 9
DESCRIPTION		l
Imaging radar using synthetic aperture radar as primary instrument. integrated with the operational land systems GDCD 0172 payload if i	as primary instrument. GDCD 0172 payload if it	it. (This payload may be it cannot go earlier.)

9 Continuous Page 2 188 Frequency (MHZ) ±30 nadir 9 0 1 7 Downlink Frequency (MHZ) 100 0 0 0 9 Ephemeris Accuracy, .Tolerance + De p Duration, hrs/day Volce (Hrs/Day) Field of view,]Hrs/Jay X Eg . th Other Tolerance Other Froquency, Hz N Digital Pointing accuracy, arc sec 360 Fointing Stability (Jitter) arc sec/sec Special Restrictions (Avoidance) Solar 🗆 400 On-Board Data Processing Required X Offiling Data Dump Frequency (Per Orbit)
Recording Rate (KBPS) 20,500 Encryption/Decryption Required Uplink Req.: Command Rate (KBS) 3 Power, ž Periges, O Inertial On-Board Storage (MBIT) Ana log Monitoring requirements: XRealtime 5000 7500 Inclination, deg 52.
Nodel Angle, deg
Escape dV Required, m/s 20 区 300 Truth Sites (1f known) ORBIT CHARACTERISTICS Live TU (Hrs/Day) POINTING/ORIENTATI<u>o</u>n DATA/COMMUNICATIONS 占 Types! (Amount) Operating Description View direction Standby Poak Inclination, Apogee, km Voltage, V Film POUER

ORIGINAL PAGE 19 OF POOR QUALITY

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GDC	CODE	0179		ELEME	NT NAME	IMAGING	RADAR	FOR	EARTH	RESOURCES	INVENTORY
ACCO	MODAT	ION:	Ø ATT	ACHED	FRE	E FLYER *	□ 0T	/ OPS			
1. \$1	TATION	ACTIVA'	TION (E.G.	, SET-UP/	ASSEMBL'	Y/ATTACHM	ENT AND	CHEC	KOUT)		
0/	ATE(S)1	996	INT.	. HRS		EVA HRS		E\	VA CREW		
	•										
	☐ NOT	APPLIC	ABLE								
2. SE	RVICE	(£.G., RE	PLENISH/	RESUPPL	Y)	•					
10	ITERVA	L	_DAYS	TOTAL	SERVICE	:S	_				
	☐ TMS	VOTV RE	QUIRED_			ST	ATION HR	IS PER	SERVICE		
	⊠ not	APPLIC	ABLE _		_	EV	A HRS PE	R SER	VICE		
						EV	A CREWS	IZE			
3. S 1	TATION	OPERAT	10NAL SU	PPORT (A	VG. TIME	FOR MONI	TOR, INSP	ECT, E	TC.)		
	0.2	_ HRS P1	ER DAY (IF	ITERNAL)						
		_HRS PI	ER DAY (E	VA)							
	□ NOT	APPLIC	ABLE								
4. RI	ECONFI	GURATI	ON								
iN	TERVA	L	_OAYS	TOTA	L RECON	FIGS					
	□ TMS	OTV RE	QUIRED			STA	ATION HR	SPER	RECONFI	G	
	⊠ NOT	APPLIC	ABLE			EV	A HRS PEF	RECO	NFIG.		
						EV	A CREW SI	ZE			
5 01	FACTIV	ATION/A	EMOVAL								
				HRS.		EVA HRS		EV#	CREW		
-									_		
	□ NOT	APPLIC	ABLE			•		_	-		
6. N	OTES (8	RIEFLY	DESCRIBE	TASKS II	N 1 THROI	JGH 5 ABO\	/E)				
*Fre	ee fly quire	yer ac re-ev	commoda aluatio	ation of a	is an a all rec	lternato quiremen	e mode, ts.	, and	ifus	ed will	
1.		ion OP	S								
3. 5.	Monit Stat	tor ion OP	S								

Page 1 of 1 Volume II, Book 1 Appendix I

Code: GDCD 0179

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Imaging Radar for Earth Resources Investigating and

Monitoring

Reference Documents:

1. Strawman Payload Data for Science and Applications Space Platforms, Final Report, SP80-MSFC-2403, January 1980

Narrative:

Soil moisture distribution, including depth, can be determined by spaceborne radar. Also the radar is useful in crop classification, snow dynamics, geological maping, etc. The primary instrument is a synthetic aperture radar.

The payload and characteristics were suggested by Dr. Fawwaz T. Ulaby of the University of Kansas.

Instrument size, etc., were obtained as typical and scaled up from Ref 1, p 60.

Schedule, crew requirements, and servicing requirements were estimated based on similarity to other payloads of this type.

	Page 1 of 3
PAYLOAD ELEMENT NAME Freeflying Imaging Radar Exp	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Name General Dynamics Convair Division	Applications (non-commercial)
Addross P.O. Box 85357 San Ofego, CA 92138	- Commercial
Telephone (619) 277-8900, Ext. 3778/2130	☐ Technology Development
ายเ	Operations
Hpproved Acandidate Opportunity	Type Number 2
ght, yr 1992 ights 1 of Flight, days 2440	Importance of the Space Station to
adar (SAR) as primary sensor to characland features, i.e., state of vegitation cal features. (Potential joint endeavor	1 = low value but Could use
Detween USA and Canada.)	Scale 1 - 10 2
DESCRIPTION Synthetic aperture radar (SAR) freeflying with large antenna ($8 \times 2.8m$) in polar orbit with 150 km swath width, 25m resolution, and global coverage every 3 days. This is the FIREX (free-flying imaging radar experiment).	2.8m) in polar orbit with ys. This is the FIREX

CODE 6 0 C 0 0 1 8 0 Page 2 of 3	iges, km 400 Tolerance + 50 Tolerance + 10 Ephemeris Accuracy, m	iertial []Solar	Power, U Duration, hrs/day 100 100 Frequency, Hz	a Of n Requir Rate (Ki sing Req	malog Digital Hrs/Day Voice (Hrs/Day) MBIT, W (Per Orbit) MS) 120,000 Downlink Frequency (MHZ)
	1,,	TION Inertial Crown) I arc sec 3600 I, arc sec 3600 I, arc sec 600	rating 7000 Power, 1000 1000 1000 1000 1000 1000 1000 10	UNICATIONS gradurements; Requirements; ption/Decryption Requir k Req.; Command Rate (Ki ard Data Processing Req	Data Types: Analog DI(Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBII, Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 120,000

OP	GINAL	PAGE	ig
OF	POOR	QUALI	TY
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c	?	OF POOR Q	UALITY	
CODE 6,0 c,0 0,180	17 = = = = = = = = = = = = = = = = = = =	S It Remote Ixed Unpressurized M		monicuring SAR venicle in 1990 (IEEE spectrum Nov 1482, Elachi and Granger).

Volume II, Book 1 Appendix I

GDCD CODE 0180 ELEMENT NAM	FREE FLYING IMAGING RADAR EXP (FIREX)
ACCOMODATION:	EE FLYER
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBI	LY/ATTACHMENT AND CHECKOUT)
DATE(S) 1992 INT. HRS	EVA HRSEVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 1220 DAYS TOTAL SERVICE	ES <u>1</u>
TMS/OTV REGUMEN ALTERNATE	STATION HRS PER SERVICE
NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIM	E FOR MONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
■ NOT APPLICABLE	•
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECO	NFIGS.
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) 1999 INT. HRS	EVA HRS EVA CREW
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THRO	DUGH 5 ABOVE)
This payload element assumes acc Leasecraft type spacecraft which	ommodation on a platform or has orbit transfer propulsion
2. Spacecraft propellant	

TOTAL EVA HRS 0

Page 1 of 1 Volume II, Book 1 Appendix I

Code: GDCD 0180

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Free-Flying Imaging Radar Experiment (FIREX)

Reference Documents:

1. Space Station NAAO Study, Orientation Meeting Handout NASA Headquarters, 14-15, September 1982

2. Spaceborne Imaging Radar Probe "In-Depth," IEEE Spectrum, November 1982, Elachi & Granger of JPL.

Narrative:

This payload is a free-flying satellite that will be used for imaging ocean, ice & land features on a global basis. It has a high probability of being a joint effort between Canada and USA. The Canadian counterpart is RADARSAT. Weight assumes no orbit transfer propulsion or support resources such as could be provided by a Leasecraft-type spacecraft or platform accommodation.

This payload element assumes accommodation on a platform or Leasecraft type spacecraft which has orbit transfer propulsion.

The basic data on requirements were taken from Ref 1, pp 8-18 and supporting data were obtained from Ref (2).

	Page 1 of 3
PAYLOAD ELEMENT NAME Z-Continuous Coverage	TYPE
W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division	Applications (non-commercial)
Address P.O. Box 85357 San Diego, CA 92138	- Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Technology
STATUS Operational Planned	Operations
	Typo Number 3
First flight, yr 1996 No. of flights 1 Duration of Flight, days 720	Importance of the Space Station to
OBJECTIVE	this Elomont
To provide a Lighly adaptable civil space facility in low Earth Orbit for long term multidisciplinary scientific study of the Earth and the development of related technology (System Z).	1 = low value but could use 10 = vital
	Scale 1 - 10 2
DESCRIPTION	
The initial system Z continuous coverage representative instruments are assembled on a Free Flying spacecraft which provides on-orbit resources as well as propulsion capability. Periodic spacecraft servicing, and man-tended instrument related functions such as sensor replacement and calibration are envisioned. The representative instruments are required to obtain systematic global ubservations at the highest possible frequency for weather and climate studies. The instrument complement is: imaging radiometers (2), thematic mapper, radar altimeter, ocean wave directional spectrometer, scanning multifrequency MW radiometer, radar scatterometer, IR/microwave sounder, multifrequency microwave limb sounder, UV spectrometer limb sounder, cryo IK gas correlation spectroradiometer, data collection system, solar monitoring package.	opulsion capability. Periodic such as sensor replacement re required to obtain system- ather and climate studies. Apper, radar altimeter, ocean ter, radar scatterometer, IR/ trometer limb sounder, cryo IK

Maria Caranto

50 Continuous Generate /Modify Observational Sequences; Special Requests & Priority Interrupt Implementation Page 2 Frequency (MHZ) 0 0 1 8 1 Downlink Frequency (MHZ) Ephemoris Accuracy, Bop Tolorance + Duration, hrs/day CODE .l ∐Hrs/Day Voice (Hrs/Day) Field of view, X Earth Other Tolerance 00ther Frequency, Hz Digital Pointing accuracy, are sec Pointing Stability (Jitter) are sec/sec Special Restrictions (Avoidance) -Solar Encryption/Decryption Required MUDIINK Req.: Command Rate (KPS) X Off line 1000 Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 125,000 Power, Perigee, km O Inertial On-Board Storage (MBIT) - Analog Realtime 3160 Monitoring requirements! 200 Escape dV Required, m/s Truth Sites (1f known) ORBIT CHARACTERISTICS Live TU (Hrs/Day) POINTING/ORIENTATION DATA/COMMUNICATIONS Data Types: Film (Amount) deg deg Description Operating View direction Standby Nodal Angle, Inclination, Poak Voltage, U None POUER

ORIGINAL PAGE 19 OF POOR QUALITY

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oo Table B) SKILL	
LEVEL	
Warre Tree California	
EUR MYES UNO Rouson INST CAISD/Change Hrs/EUR 20	
SERVICEING.MAINTENANCE SERVICE:Interval, days 365 Consumables, kg 1860	
dan Han Hours 16	
les, kgReturnables, kg	
lons	
May require 2 satellites phased 180 degrees apart in 500 KM orbit or one satellite at 500 Km at >1000 Km to obtain global weather coverage. Deployed width includes solar array.	

Volume II, Book 1 Appendix I

GDCD CODE 0181 ELEMENT NAME Z-CONTINUOUS COVERAGE					
ACCOMODATION: ATTACHED	☑ FREE FLYER □ OTV OPS				
1. STATICH ACTIVATION (E.G., SET-UP/	ASSEMBLY/ATTACHMENT AND CHECKOUT)			
DATE(S) 1996 INT. HRS	EVA HRS 8 EVA CR	EW			
☐ NOT AFPLICABLÉ					
2. SERVICE (E.G., REPLENISH/RESUPPL	.Y)				
INTERVAL 365 DAYS TOTAL	L SERVICES 1				
(X) TMS/OTV REDUXRED ALTER	NATE STATION HRS PER SERV	ICE _16			
□ NOT APPLICABLE	EVA HRŞ PER SERVICE				
	EVA CREW SIZE				
3. STATION OPERATIONAL SUPPORT (A	AVG. TIME FOR MONITOR, INSPECT, ETC.)				
HRS PER DAY (INTERNAL					
HRS PER DAY (EVA)	••	•			
■ NOT APPLICABLE					
_					
4. RECONFIGURATION					
INTERVAL 365 DAYS TOTA		1.0			
TMS/OTV REQUIRED	STATION HRS PER RECON				
☐ NOT APPLICABLE	EVA HRS PER RECONFIG.	12			
	EVA CREW SIZE				
5. DEACTIVATION/REMOVAL					
DATE(S) 1998 INT. HRS.	EVA HRS EVA CREV	y			
NOT APPLICABLE					
6. NOTES (BRIEFLY DESCRIBE TASKS II	N 1 THROUGH 5 ABOVE)				
This payload element has or	rbit transfer propulsion				
1. Instrument calibration					
Satellite service for procured concurrence	propellants may be required - urrent with Item 4.	if needed,			
4. Instrument or instrumer					

TOTAL EVA HRS 20

Page 1 of 5 Volume II, Book 1 Appendix I

Code: GDCD 0181

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Z-Continuous Coverage

Reference Documents:

1. Science and Applications Requirements Supplement, System Z, NASA HQ, 11 January 1983.

Narrative:

The system Z continuous coverage payload element is described in Ref (1) as the "starter set" of the system Z series of interdisciplinary earth observations conducted from high inclination orbit. A free-flying accommodation is described, Ref (1).

Crew related data, service data and launch mission duration data are derived. Power level is for science payload only. The deployed width includes solar panels.

The payload is assumed to be delivered to low altitude orbit by the shuttle. Final orbit would be achieved using spacecraft propulsion. Servicing could use TMS/OTV.

Remaining data from Ref 1

Page 2 of 5 Volume II, Book 1 Appendix I

Code: GDCD 0181

PAYLOAD ELEMENT SYNTHESIS

INSTRUMENT	WT (kg)	POWER (kW)	DATA RATE (kbps)	CHARACTERISTICS	SPECIAL REGUIREMENTS
I. MODERATE FOV IMAGING RADIOMETER (MFIR)	100	0.1	30,000	50-12,000 m RES, 400-800 km SWATH WIDTH, 11 BANDS 0.4-12.5 µm 100-500 nm RES	0.1 mrad POINTING STABILITY CRYU DET T
2. WIDE FOY IMAGING RADIOMETER (WFRR + 1 AVHRR + OCI)	50	0.05	10,000	300-600 m RES, 1000-2000 km SWATH 10-20 nm BANDS 0.4-0.6 \$ VIS-TIR BANDS, 0.4-12.5 µ m, 200-1000 nm RES	0.6 mrad POINTING STABILITY CRYO DET T
3. TM EQUIVALENT	250	0, 35	8 5,000	30 m RES, 185 nm SWATH, 80 nm - 1200 nm RES 7 BANDS, 0.4-12.5	0.020 mrad STABILITY CRYO DET T
4. RADAR ALTIMETER	150	0.2	10	1.2-12 km FOOTPRINT, NADIR- LOOKING, 13 GHz, 1 m ANT., MODIFIED FOR SIMULTAMEOUS DPT MEAS	NONE
5. OCEAN WAVE DIRECTIONAL SPECTROMETER (OWDS)	100	0.1	1	14 GHz	1M CONICAL SCAN (10° CONE ANGLE)
6. SCANNING MULTIFREQUENCY MICROWAVE RADIOMETER (LAMMR)	300	0.5	200	6-50 GHz	4M CONICAL SCAN (60° CONE ANGLE)
7. RADAR SCATTEROMETER	150	0.2	10	13 GHz, 100° FOV	6 2M STICK ANTENNAS

266.592-415

Representative Payload

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Code: GDCD 0181

PAYLOAD ELEMENT SYNTHESIS

	INSTRUMENT	WT (kg)	POWER (kW)	DATA RATE (kbps)	CHARACTERISTICS	SPECIAL REQUIREMENTS
8.	IR/MICROWAVE SOUNDER (HIRS + MSU + SSN) SUSSKIND/CHAHINE	SIZE 1.5x 3x 0.8M 380	0.32	6.6	I FOV 5 km IR, 25 km μWAVE SCAN ±45° 28 IR CHANNELS 3.7 16.5 μπ 20 μWAVE CHANNEL., 22-60 GHz	AMTS + AMSU
9.	MULTIFREQUENCY MICROWAVE LIMB SOUNDER	100	0.4	10	10-200 CH2	LIMB POINTABLE
10.	UV SPECTROMETER LIMB SOUNDER	100	0.2	10	SIMILAR TO NIMBUS SBUV/TOMS	LIMB POINTABLE
11.	CRYO IR GAS CORRELATION SPECTRORADIOMETER	300	0.5	200	2.5-25µ COMBINATION OF GAS CORRELATION AND CRYO COOLED IR SPECTROMETERS	LIMB POINTABLE
12.	DATA COLLECTION AND LOCATION SYSTEM (DCLS)	200	0. 1	10	50 KHz B,W, AT 400 MHz	4 10M BOOMS 120° FOV DISH
13.	SOLAR MONITORING PACKAGE LOW RES SPECTROMETER BROADBAND RADIOMETER	125 20	0, 13 0, 01	1 0.17	EUV AND UV VIS AND IR 0.4-50 m	SUNWARD LOOKING
•	TOTALS	2325 kg	3. 16 kW	125,000 kups		
				(125 Mbits)		266.592.41

Representative Payload (contd)

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Code: GDCD 0181

PAYLOAD ELEMENT SYNTHESIS

SUBSYSTEM	MASS (kg)	POWER (kW)
TELECOM	83	0.25
POWER	830	0.20
COMMAND / DATA	150	0.75
DATA STORAGE	142	0.50
AACS	1100	0.92
PROP (DRY)	538	0.31
STRUCTURE, CABLING, THERMAL CONTROL	1550	0.50
PAYLOAD	2325	3.16
SUBTOTAL:	6718	6.59
PROPELLANT *	1860	
LAUNCH WT	8578	

*3 LMSC 1.57 x 0.93 m N_2H_4 TANKS

266.502-417

Configuration Sizing

Code:

GDCD 0181

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PAYLOAD ELEMENT SYNTHESIS

266.592-409 ATTITUDE DET AND CONTROL
COMMAND AND DATA HANDLING
TITLECOMMUNICATIONS SCIENCE RADAR ALTINETER OWDS IR SPECIRORADIONETER SCIENCE IR/MICROWAVE SOUNDER UV LIMB SOUNDER SCIENCE
THEMATIC MAPPER
METR
WETR
MLS
SCATTEROMETER PROPULSION SCIENCE LAMMP DCLS POWER SOLAR ARRAY 4M x 32M Θ Θ 0 0 ⊕ • 9 -SOLAR ARRAY 4M x 32M System Z On Orbit Configuration SPECTRORADIOMETER • ල € SCATTEROMETER 0 DCLS (SINGLE AXES) TOTAL LENGTII-16.M 0

		C PBG
. NAME	CODE	TYPE
Z-Hydrologic Cycle Priority	6 D c D O 1 8 2	• ************************************
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Duramics Coursin Division		Applications
D33 P.0. Box		
San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Technology
STATUS		THORACIBORA
Operational Operational	ď	□ Operations
☐ Approved	late unitu	Tens Number
ag		(see Table A)
A STATE OF THE STA		
Duration of Flight, days 720		Importance of the Supra Station to
OBJECTIVE To provide a highly adaptable civil space facility	il space facility	
in Low Earth Orbit for long term multidisciplinary scientific	nary scientific	
study of the Earth and the development of related technology	ted technology	1 - low value but
(system Z). This so called "Red" payload has been chosen to	been chosen to	
_	le including sea	10 - vital
ice, biomass, land cover/land use and provide major contribu-	major contribu-	
tions in the areas of climate continental geology and atmospherid Scale 1 - 10 circulation.	ogy and atmospherid	Scale 1 - 102
DESCRIPTION This payload element provides a plateau in system and evolution.	plateau in system	and evolution. A mix of
	uments are assemble	and special coverage instruments are assembled on a Free Flying spacecraft
which provides on orbit resources as well as propulsion capability. Periodic spacecraft ser-	ropulsion capabilit	y. Periodic spacecraft ser-
vicing and man-tenged functions such as replacement and calibration of sensors are envisioned.	ement and calibration	on of sensors are envisioned.
The instrument complement to accomplish the objectives are: wide FOV imaging radiometer,	jectives are: wide	FOV imaging radiometer, scan-
ning multi-trequency microwave radiometer, IR microwave sounder, data collection system (con- tingus coverage instruments) as well as the following special coverage instruments - hi re-	microwave sounder, ollowing special co	data collection system (con- verage instruments - hi re-
solution imaging radiometer, multi-frequency, multi-polarization, multi-lock angle synthetic	multi-polarization,	multi-lock angle synthetic
aperture radar.		

CODE G.D.C.D.O.1.8.2 Page 2 of 3
- L
ing accuracing Stabili
OUER AC
MMUNICATIONS Ing requirements!
Required (RBS)
bservation Sequences; Special Reque
Film (Amount) Live TU (Hrs/Day)
Jump Frequen ding Rate (K

હ

CODE 6.0.c.0.0.1.8.2 Page 3.6.3
Equipment ID/Function Pressurized Unpressurized Equipment ID/Function Pressurized Unpressurized L,m 16 U,m 4.5 H,m 4.5 Stowed L,m 31 U,m 45.0 H,m 4.5 Deployed Launch mass, kg Consumables Types Acceleration sensitivity, a min
Task Assignment
Skills (Soo Table B) SKILL SKILL
By Inst Calibr/Change
Consumables, kg 1860
CONFIGURATION CHANGES Interval, day 365 Man/Hrs Req. 24
ons
Deployed length includes synthetic aperture radar (15 M); deployed width includes solar array. Data relay rate is time shared not to exceed 300 MBPS; >600 MBPS direct to ground. May require two satellites phased 180 degrees in 500 Km orbit or one satellite at 500 Km and one at >1000 Km to obtain global coverage.

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GOCO CODE 0182 ELEMENT NAME Z-	HYDROLOGIC CYCLE
ACCOMODATION: ATTACHED THE FLY	YER
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATT	ACHMENT AND CHECKOUT)
DATE(S) 1998 INT. HRSEVA	HRS 8 EVA CREW 1
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 365 DAYS TOTAL SERVICES 1	
(X) TMS/OTV MEGIZINDED ALTERNATE	STATION HRS PER SERVICE
□ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR	MONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA).	
⊠ NOT APPLICABLE	
E No. W. County	
4. RECONFIGURATION	_
INTERVAL 365 DAYS TOTAL RECONFIGS.	
☑ TMS/OTV REBUINGO ALTERNATE	
☐ NOT APPLICABLE	EVA HRS PER RECONFIG. 12
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) 2000 INT. HRS EVA	HRSEVA CREW
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 This payload element has orbit trans-	
 Instrument calibration Satellite service for propellants performed concurrent with Item 4 Instrument or instrument module of 	

TOTAL EVA HRS 20

3

Page 1 of 4 Volume II, Book 1 Appendix I

Code: GDCD 0182

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Z-Hydrologic Cycle Priority

Reference Documents:

1. Science and Applications Requirements Supplement, System Z, NASH HQ, 11 January 1983.

Narrative:

The system Z hydrologic priority payload element is described in Ref (1) as the "red" payload of the system Z series of interdisciplinary Earth observations conducted from high inclination orbit. A free-flying accommodation is described (Ref 1).

It was assumed that this payload element was delivered by the shuttle. Final orbit would be achieved using spacecraft propulsion. Servicing could use TMS/OTV. A possible approach is to perform major reconfiguration of GDCD 0181 on the ground (or possibly on orbit) after about two years of operation.

Crew-related data, service data, and launch/mission duration data are derived. Power level is for instruments only and is derived assuming that for peak power all red payload instruments are "on", and for average power all instruments except special coverage instruments are "on". Relay data rate is assumed to be time-shared. Maximum data rate to the ground will be 600 MBPS.

Remaining data from Ref 1

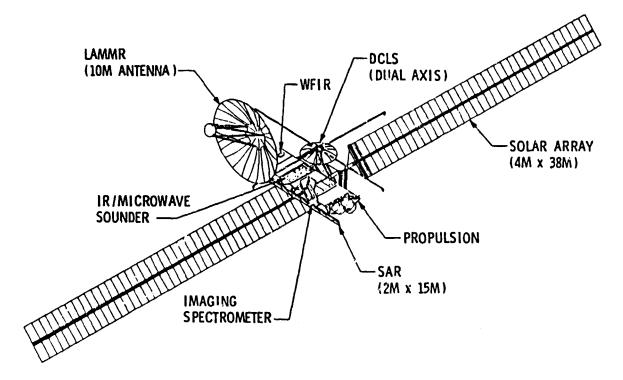
ORIGINAL PAGE 18 OF POOR QUALITY

GDC-ASP-83-002

Page 2 of 4 Volume II, Book 1 Appendix I

Code: GDCD 0182

PAYLOAD ELEMENT SYNTHESIS

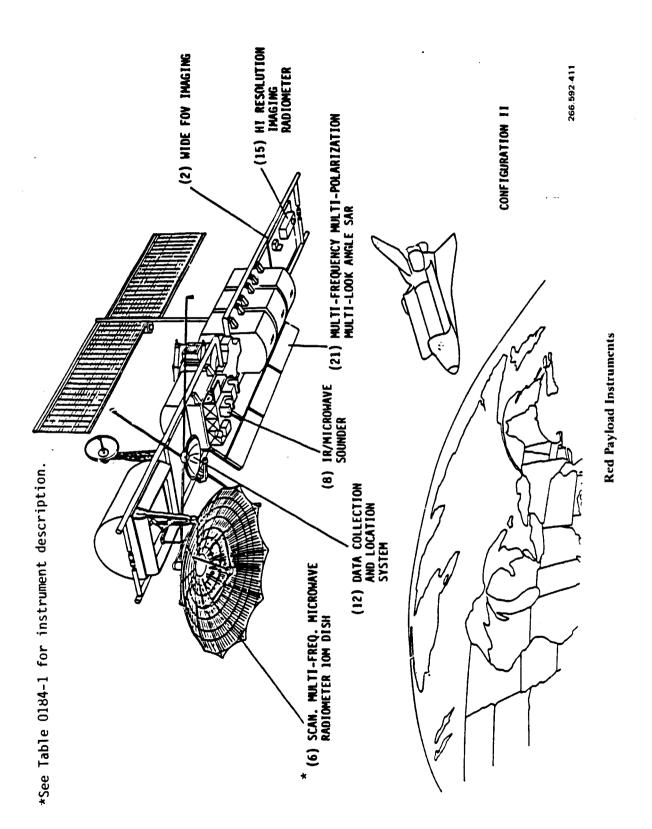


266.592-410

System Z Red Payload

Code: GDCD 0182

PAYLOAD ELEMENT SYNTHESIS



Page 4 of 4 Volume II, Book 1 Appendix I

Code: GDCD 0182

PAYLOAD ELEMENT SYNTHESIS

SUBSYSTEM	MASS (kg)	POWER (kW)
TELECOM	83	0.25
POWER	925	0.31
COMMAND / DATA	150	0.75
DATA STORAGE	142	0.50
AACS	1100	0.92
PROP (DRY)	538	0.31
STRUCTURE, CABLING, THERMAL CONTROL	1580	0.50
PAYLOAD	2330	7.97
SUBTOTAL:	6848	11.51
PROPELLANT	1860	
LAUNCH WT	8708	

^{*3} LMSC 1.57 m \times 0.93 m N_2H_4 TANKS

266.592-418

Configuration Sizing Red Payload

PAYLOAD ELEMENT NAME Z-Special Coverage CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division P.O. Box 85357 San Diego, CA 92138 Telephona (619) 277-8900, Ext. 3778/2130 STATUS C. Doporational C. Doporational C. Doporational C. Doporational C. Doporational C. Condidate C. Doportunity First flight, yr 2000 No. of flights Duration of Flight, days To provide a highly adaptable civil space facility in Low Earth	
terson MZ 21-9530 cs Convair Division 92138 Ext. 3778/2130	
CONTACT W. Hardy/J. Peterson MZ 21-9530 Name General Dynamics Convair Division Address P.O. Box 85357 San Diego, CA 92138 Telephone (619) 277-8900, Ext. 3778/2130 STATUS Cloperational (X) Candidate Clopportunity First flight, yr 2000 No. of flights 1 Duration of Flight, days 720 OBJECTIVE To provide a highly adaptable civil space facility in Low E	Applications (non-commercial) Commercial Technology Development
Telephone (619) 277-8900, Ext. 3778/2130 STATUS Cloperational Approved Clopportunity First flight, yr 2000 Duration of flights To provide a binhly adaptable civil space facility in Low E	Commercial Technology Development
Telephone (619) 277-8900, Ext. 3778/2130 STATUS Governtional Sycandidate Approved Sycandidate Opportunity First flight, yr 2000 No. of flights 1 Duration of Flight, days 720 OBJECTIVE To provide a highly adaptable civil space facility in Low E	Development
STATUS Cloperational Cloperational Cloperational Cloperational Cloperational Cloperation of Flight, days Duration of Flight, days Condition of Flight, days To provide a highly adaptable civil space facility in Low E	
First flight, yr 2000 No. of flights 1 Duration of Flight, days 720 OBJECTIVE	Charactons
First flight, yr 2000 No. of flights 1 Duration of Flight, days 720 OBJECTIVE To provide a bighly adaptable civil space facility in Low E	Type Number 3
OBJECTIVE To provide a bighly adaptable civil space facility in Low E	Importance of the Space Station to
	this Element
- 0	irth 1 = low value but ie could use 10 = vital
	Scale 1 - 10 2
DESCRIPTION The growth version system and configuration includes special coverage representative instruments assembled on a Free-Flying spacecraft which provides on-orbit resources as well as propulsion capability. Periodic spacecraft servicing and man-tended instrument related functions such as sensor replacement and calibration are envisioned. The representative instruments are time-shared between disciplines and include both advanced technique development and research tasks and systematic global observations which can be separated by weeks or months. The instrument complement is: imaging spectrometer, high resolution imaging radiometer, thermal IR multispectral imager, scanning laser ranger, multifrequency LIDAR facility, real aperture radar facility, precision fast scanning large aperture microwave radiometer scatterometer, multifrequency, multipolarization, multilook angle synthetic aperture radar.	icludes special coverage representich provides on-orbit resources as ig and man-tended instrument relatenvisioned. The representative both advanced technique developthich can be separated by weeks or high resolution imaging radiomemalifrequency LIDAR facility, aperture microwave radiometers.

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ORIGINAL PAGE 19 OF POOR QUALITY

		7 7 7 7 7 7			_
CODE GDCDD183 Page 2 of	ORBIT CHARACTERISTICS Apogee, km 1000 Perigee, km 1000 Tolerance + 0 0 600 Inclination, deg 100 Tolerance + 4 Nodal Angle, deg Ephemeris Accuracy, m Ephemeris Accuracy, m	POINTING/ORIENTATION Use direction Inertial Solar Earth Truth Sites (if known) Pointing accuracy, arc sec_ Pointing Stability (Jitter) arc sec/sec Special Restrictions (Avoidance)	rating ndby k	MUNICATIONS ng requirements! Realtime [X]Of gption/Decryption Requirement Req.: Command Rate (Kiner Processing Requirement Data Processing Requirement	88 8

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C	າ							
8 3	1 1	Stowed Deployed				3720	kg	Deployed length includes synthetic aperture radar (15m); deployed width includes solar array. Data relay rate is time-shared not to exceed 300 MBPS; 1,000 MBPS direct to ground. May require 2 satellites phased 180 degrees apart in 500 Km orbit, or one satellite at 500 Km and one at >1000 Km to obtain global coverage.
DE 0 0 1 8 3			X 9 M				Returnables,	include to gro
CODE 6.0 c	X X X X 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	1zed 4.5 4.5 18.821 ellants			72/ - 72	kg 16	Roter	d width S direct one sate
		H, M H, M H, M H, M B21 Propellants	3 4 5		ge.	ables,		deploye, ,000 MBP; oit, or (
		Remote Unpressurized 45.0 H, m 18.82 Propellar	Task Assignment		Hrs/Day Reason Inst Calibr/Change	Consummbles, kg		Deployed length includes synthetic aperture radar (15m); deployed width includes solobata relay rate is time-shared not to exceed 300 MBPS; 1,000 MBPS direct to ground. quire 2 satellites phased 180 degrees apart in 500 Km orbit, or one satellite at 500 one at >1000 Km to obtain global coverage.
	ni min ni min ni min	E S S S S S S S S S S S S S S S S S S S	ask As		nst Cal	dau	s, kg	re radar eed 300 rt in 50
	Passive operational non-operational operational non-operational non-operational		. ,	SKILL LEVEL	Hrs/Day	365		apertu to exc ees apal
	Passive operation operation operation	CHARACTERIST nal Extar lon Prass L,m 33 L,m 33 Caunch mass, Consumables Acceleration		<u> </u>		ka Inter	De 11v	ynthetik ared not 180 degr global c
		YSICAL CHI Internal /Function L,m L,m Con		la B)	0 10 10 10 10 10 10 10 10 10 10 10 10 10	ENANCE 1, days 1blos, k HANGES!	RATION	cludes s time-sh phased obtain
	4 L U	H 11	REQUIREMENTS Size	Skills (See Table	S	SERVICING/MAINTENANCE SERVICE: Interval, days Returnables, kg CONFIGURATION CHANGES:Interval.	SPECIAL CONSIDERAT	Deployed length includes synthetic apertur Data relay rate is time-shared not to exce quire 2 satellites phased 180 degrees apar one at >1000 Km to obtain global coverage.
	THERMAL —Active Temperature, Heat Rejective	EQUIPMENT Location! Equipment		113 (5	X YES	VICING VICE 1 I R	SIAL C	loyed le relay e 2 satu at >1000
L	H 6 5	E 4 c	Crew	2×1	EVA	SER! CONF	SPE	Depl Data quir one

GDC-ASP-83-002 PAYLOAD ELEMENT CPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 0183 ELEMENT NAME Z-S	PECIAL COVERAGE
ACCOMODATION: ATTACHED THE FLY	ER 🔲 OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	ACHMENT AND CHECKOUT)
CATE(S) 2000 INT. HRSEVA	HRS 8 EVA CREW 1
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 365 DAYS TOTAL SERVICES	1
☑ TMS/OTV RECUMED ALTERNATE	STATION HRS PER SERVICE 16
☐ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR M	IONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
☑ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL365 DAYS TOTAL RECONFIGS.	1
(A) TMS/OTV REGIMED ALTERNATE	
	EVA HRS PER RECONFIG. 12
	EVA CREW SIZE
E OF ACTIVATION/BEMOVAL	
5. DEACTIVATION/REMOVAL DATE(S) INT. HRS EVA H	. SVA COSIM
DATE(S) INT. MAS EVA N	nsEVA CREW
NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 A	ABOVE)
This payload element has orbit transf	er propulsion.
1. Instrument calibration	
2. Satellite service for propellants	may be required. If needed, could
be performed concurrent with Item 4. Instrument or instrument module c	hangeout.
5. Operations continue after year 20	00.

TOTAL EVA HRS 20

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Code: GDCD-0183

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Z-Special Coverage

Reference Documents:

1. Science and Applications Requirements Supplement, System Z, NASA HQ, 11 January 1983.

Narrative:

The system Z special coverage payload element is described in Ref (1) as the growth version of the system Z series of interdisciplinary earth observations conducted from high inclination orbit. A free-flying accommodation is described in Ref (1).

The delivery weight of this payload element will require both the shuttle and on board propulsion. Servicing will be by the OTV.

The payload could possibly be reconfigured from GDCD 0182 on the ground (or on orbit) after about two years of operation.

Crew, service weight, and launch/mission duration data are derived. Power level is for instruments only and is time shared so as not-to-exceed 10 KW (Ref 1). Relay data rates are time-shared to 300 bps level (Ref 1).

Remaining data derived.

(

Page 2 of 4 Volume II, Book 1 Appendix I

Code: GDCD 0183

PAYLOAD ELEMENT SYNTHESIS

From Ref 1.

INSTRUMENT	WT (kg)	POWER (kW)	DATA RATE (kbps)	CHARACTERISTICS	SPECIA! REQUIREMENTS
14. IMAGING SPECTROMETER	500	2	300,000	10M SPATIAL RES, 20 nm SPEC(RAL, 0.4-2.5 µm, 10 km SWATH (240 BANDS)	2 π POINTABLE WITH 0.01 mr ad STABILITY CRYO DET
15. HI RES IMAGING RADIOMETER (PHIR)	600	0.6	300,000	5 10M SPATIAL RES, 100 km SWATH, 24 BANDS BETWEEN 0.4-12." µm 20 nm 20 nm SPECTRAL	2 m POINTABLE WITH 0.1 mrad STABILITY CRYO DET T
16. THERMAL IR MULTI- SPECT, IMAGER (TIMS)	300	0.2	10,000	8-13, 100M SPATIAL RES, 50 km SWATH 200-500 nm	2 # POINTABLE CRYO DET T
17. SCANNING LASER RANGE (LR + SLA)	500	10	300	0.5 3M VERT RES, 50 m HORIZONTAL	SCAN ±45° CROSS-TRACK
18. MULTIFREQUENCY LIDAR FACILITY	2300	3-10	2000	0.3-13, 1.2M DIA TELESCOPE, 3M LONG	LASER CHANGEOUT 45° CONICAL SCAN MIRROR
19. REAL APERTURE RADAR FACILITY (GP-1)	1500	1	1000	6-35 GHz .	10M CONICAL SCAN (0-80° CONE ANGLE) ANT., 30 rpm

266.592-419

INSTRUMENT	WT (kg)	POWER (kW)	DATA RATE (kbps)	CHARACTERISTICS .	SPECIAL REQUIREMENTS
20. PRECISION FAST SCANNING LARGE APERTURE MICRO- WAVE RADIOMETER / SCATTEROMETER (PF)	1000	0.5	100	30-200 GHz	10 mrad POINTING ACCURACY 4M CONICAL SCAN (0-80° CONE ANGLE) ANT., 30 rpm
21. MULTIFREQUENCY, MULTIPOLARIZ, MULTILOOK ANGLE SAR	800	5	300,000	25M RES, 100 km SWATH	2 x 15 m PLANAR ARRAY POINTABLE 0-60° CROSS TRACK (ONE SIDE)
TOTALS	7500	30 ITIME- SHARED INTO 10 kW)	912,000 kbps (TIME- SHARED INTO 300 Mbps LINK)		

266.592-420

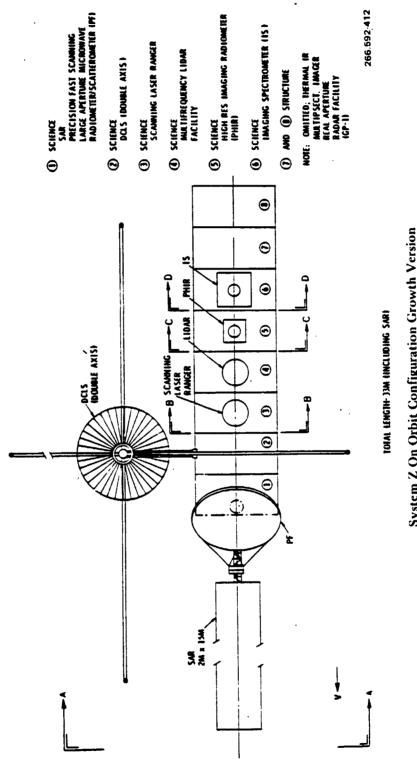
Representative Payload Special Coverage Instruments



GDCD 0183 Code:

PAYLOAD ELEMENT SYNTHESIS

From Ref 1.



System Z On Orbit Configuration Growth Version

Page 4 of 4 Volume II, Book 1 Appendix I

Code: GDCD 0183

PAYLOAD ELEMENT SYNTHESIS (Contd)

Payload Element Weight Estimate*

		Weight	(kg)
Telecom		83	
Power		1250	
Command/Data		150	
Data Storage		.142	
A ACS		1900	
Prop (dry)		1076	
Structure, Cabling, Thermal Control		3000	
Payload		<u>7500</u>	
	Subtotal	15101	
Propellant (N ₂ H ₄)		3720	
Launch Weight		18821	

(*Derived from Ref 1)

ORIGINAL TOP TO OF POOR QUALITY

4		C 10 T 0511
PAYLOAD ELEMENT NAME Z-Cont and Special Coverage	CODE 6 D C D O 1 8 4	TVPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division Address P.		Applications (non-commercial)
San Diego, CA 92138		- Commercial
Telephone (619) 277-8900, Ext. 3778/2130		- Technology
STATUS		
Operational Operational Scandidate	date	Operations
	Opportunity	Type Number 3
First flight, yr 2002		(see Table A)
No. of flights 1 1 2650 Duration of Flight, days 3650		Importance of the Space Station to
		this Element
To provide a permanent, highly adaptable civil space facility in low Earth orbit for the scientific study of the Earth and the continuing development of related technology.	l space facility in the Earth and the	1 - low value but could use 10 - vital
	V	Scale 1 - 10 8
DESCRIPTION		
The system Z full payload contains 20 sensor packages. Many operating simultaneously in the UV to MW wavelengths, to support interdisciplinary research in Earth sciences. The payload is accommodated on a manned polar orbiting space station to provide global coverage, with man fulfilling the role of scientist, construction/servicing crew, and coordinator with ground-based researchers.	packages. Many opera inary research in Eau bace station to provid iction/servicing crew	ating simultaneously in the rth sciences. The payload de global coverage, with , and coordinator with

ORIGINAL PAGE IS OF POOR QUALITY

Frequen fline 10 E06		Pointing accuracy, arc sec 412 Field of view, deg 180 Pointing Stability (Jitter) arc sec/sec Special Restrictions (Avoidance)	ORIENTA	pogee, km 500 Perigee, km 500 Tolerance + 500 100 nclination, deg 22.5 7.5 odal Angle, deg Ephemeris Accuracy, m	GDE 6 0 0 1 8 4 Pege 2 6: 3
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ORIGINAL PAGE TO OF POOR QUALITY

	m			 			
	Page 3 of	Stowed Deployed	max e Facility		203	Roq. 2	
CODE	X B E W X B E	Surizor	Ope.		Update, Calib.Hrs/EUA	Returnables	·
	lonal min lonal min lonal min	2 E E 9	Task Assignment		30 Co	bles, kg truction	
	deg C operationa non-operationa n, w operationa n, w operationa	PHYSICAL CHARACTERISTICS Internal External ID/Function Pressuri L,m 38 U, L,m 38 U, Launch mass, kg Consumables Type	'		CE CE	Deliver	
		EQUIPMENT PHYSI Location: OI Equipment ID/Fu	CREU REQUIREMENTS Crew Size	271113 :308 188 68		SPECIAL CONSIDERA	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GOCO CODE 0184	ELEMENT NAME	Z-CONT	INUOUS	AND SPEC	IAL COVERAGE
ACCOMODATION: X AT	TACHED	E FLYER	□ oπ	/ OPS	
1. STATION ACTIVATION (E.	G., SET-UP/ASSEMBLY	/ATTACHN	ENT AND	CHECKOUT)	
DATE(S) 2002 IN	T. HRS	EVA HRS	60	EVA CRE	w 2
■ NOT APPLICABLE					
2. SERVICE (E.G., REPLENISH	RESUPPLY.				
INTERVAL 90 DAYS	SERVICE	s <u>35</u>			
TMS/OTV REQUIRED		ST	ATION HR	S PER SERVI	E3
NOT APPLICABLE		EV	A HRS PE	RSERVICE	3
		٤٧	A CREW S	IZE	_1
3. STATION OPERATIONAL S	UPPORT (AVG. TIME	FOR MONIT	ror, inspe	ECT, ETC.)	
2.0 HRS PER DAY (INTERNAL)				
HRS PER DAY (· EVA)				
☐ NOT APPLICABLE					
4. RECONFIGURATION					
INTERVAL 180 DAYS	TOTAL RECON	ins 19			
☐ TMS/OTV REQUIRED		·		PER PECAN	FIG. <u>2</u>
□ NOT APPLICABLE		_	•		2
MOT APPLICABLE			A CREW SI		1
F					
5. DEACTIVATION/REMOVAL					
DATE(S)INT	T. HRS	EVA HRS _		_ EVA CREW	
■ NOT APPLICABLE		-			
6. NOTES (BRIEFLY DESCRIB	E TASKS IN 1 THROU	GH 5 ABOV	'E)		
1. Station OPS - re	escheduled bev	ond vea	r 2000		
3. Operate multidis	scipline facil	ity (e.	g. targ	et acquis	sion,
anamoly detection 5. Payload operation		eyond v	ear 200	0	

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Code: GDCD 0184

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Z-Continuous and Special Coverage

Reference Document:

1. Science and Applications Requirments Supplement, System Z, NASA Hq., 11 January 1983.

Narrative:

This payload element contains the full System Z instrument complement as shown in Table 0184-1. The complement is from Ref 1.

This is a multi-disciplinary payload that covers all areas of Earth resources, weather and climate and crustal motion. In the year 2002-2012 time frame it will replace the use of many individual free-flyers. Utilization of sensors is shown in Table 0184-2.

All instruments comprising this payload are developed and proven out on free-flyers during the 1990s decade.

This payload is configured as two integrated sets of instruments, similar to the configurations of the "Continuous Coverage" and "Special Coverage" free-flyer payload complements. The weight estimate is based upon the breakout given in Table 0184-3.

The two integrated instrument carriers can be delivered by multiple shuttle flights. EVA is required to assemble and checkout the payload, and for periodic servicing and updating.

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Code: GDCD 0184

PAYLOAD ELEMENT SYNTHESIS

Table 0184-1. System Z Instruments

	INSTRUMENT	WT (kg)	POWER (kW)	DATA RATE (kbps)	CHARACTERISTICS	SPECIAL REQUIREMENTS
1.	MODERATE FOV IMAGING RADIOMETER (MFIR)	100	0.1	30,000	50-12,000 m RES, 400-800 km SWATH WIDTH, 11 BANDS 0.4-12.5μm 100-500 nm RES	O.1 mrad POINTING STABILITY CYRO CRYO DET T
2.	WIDE FOV IMAGING RADIOMETER (WRFF + 1 AVHRR+OCI) (WFIR)	50	0.05	10,000	300-600 m RES, 100-200 km SWATH 10-20 nm BANDS 0.4-0.6 8 VIS-TIR BANDS, 0.4-12.5 m, 200-1000 nm RES	O.6 mrad POINTING STABILITY CRYO DET T
3.	TM EQUIVALENT (TM)	250	0.35	85,000	30 m RES, 185 nm SWATH, 80 nm-1200 nm RES 7 BANDS, 0.4-12.5	0.020 mrad STABILITY CRYO DET T
4.	RADAR ALTIMETER	150	0.2	10	1.2-12 km FOOTPRINT, NADIRLOOKING, 13 GH _Z , 1 m ANT., MODIFIED FOR SIMULTANEOUS DPT MEAS	NONE
5.	OCEAN WAVE DIRECTIONAL SPECTROMETER (OWDS)	100	0.1	1	14 GHz	1M CONICAL SCAN (10 JUNE ANGLE)
6.	SCANNING MULTIFRE- QUENCY MICRO- WAVE RADIO- METER (LAMMR)	300	0.5	200	6-50 GHz	4M CONICAL SCAN (60 CONE ANGLE)
7.	RADAR SCATTERUMETER	150	0.2	10	13 GHz, 100 FOV	6 2M STICK ANTENNAS

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Code: GDCD 0184

PAYLOAD ELEMENT SYNTHESIS

Table 0184-1. System Z Instruments

8.	IR/MICROWAVE	(SIZE 1.5x 3x 0.8M) 380	0.32		1 FOV 5 km IR, 25 km WAVE SCAN 45 28 IR CHANNELS 3.7-16.5 m 20 WAVE CHANNELS, 22-60 GHZ	AMTS + AMSU
9.	MULTIFRE- QUENCY MICRO- WAVE LIMB SOUNDER (MLS)	100	0.4	10	10-200 GH≱	LIMB POINTABLE
10.	UV SPECTRO- METER LIMB SOUNDER	100	0.2	10	SIMILAR TO NIMBUS SBUV/TOMS	LIMB POINTABLE
11.	CRYO IR GAS CORRELATION SPECTRO- RADIOMETER	300	0.5	200	2.5-25 COMBINATION OF GAS CORRELATION AND CRYO COOLED IR SPECTROMETERS	LIMB POINTABLE
12.	DATA COLLEC- TION AND LOCATION SYSTEM (DCLS)	200	0.1	10	50 KHz B.W. at 400 MHz	4 10M BOOMS 120 FOV DISH
13.	SOLAR MONI- TORING PACK- AGE					SUNWARD LOOKING
	LOW RES SPECTROMETER BROADBAND RADIOMETER	125 20	0.13 0.01	0.17	EUV AND UV VIS AND IR 0.4-50 m	
14.	IMAGING SPEC- TROMETER (IS)	500	2	300,000	10M SPATIAL RES. 20 nm SPECTRAL, 0.4- 2.5 m, 10 km SWATH (240 BANDS)	2 POINTABLE WITH 0.01 mrad STABILITY CRYO DET T
15.	HI RES IMAGING RADIOMETER (PHIR)	600	0.6	300,000	5 10M SPATIAL RES, 100 km SWATH, 24 BANDS BETWEEN 0.4-12.5 m 20 nm 20 nm SPECTRAL	2° POINTABLE WITH 0.1 mrad STABILITY CRYO DET T
16.	THERMAL IR MULTISPECT, IMAGER (TIMS)	300	0.2	10,000	8-13, 100M SPATIAL RES, 50 km SWATH 200-500 nm	2° POINTABLE CRYO DET T
17.	SCANNING LASER RANGER (LR + SLA)	500	10	300	0.5 3M VERT RES, 50 m HORIZONTAL	SCAN 45° CROSS-TRACK

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Code: GDCD 0184

PAYLOAD ELEMENT SYNTHESIS

Table 0184-1. System Z Instruments

18.	MULTIFRE - QUENCY LIDAR FACILITY	2300	3-10	2000	O.3-13, 1.2M DIA TELESCOPE, 3M LONG	LASER CHANGE- OUT 45 CON- ICAL SCAN MIRROR
19.	REAL APER- TURE RADAR FACILITY (GP-1)	1500	1	1000	6-35 GHz	10M CONICAL SCAN (0-80 CONE ANGLE) ANT., 30 rpm
20.	PRECISION FAST SCAN- NING LARGE APERTURE MICROWAVE RADIOMETER/ SCATTEROMETER (PF)	1000	0.5	100	30-200 GHz	10 mrad POINT- ING ACCURACY 4M CONICAL SCAN (0-80 CONE ANGLE) 30 rpm
21.	MULTIFRE- QUENCY, MULTIPOLARIZ, MULTILOOK ANGLE SAR (SAR)	800	5	300,000	25M RES, 100 km SWATH	2 x 15 m PLANAR ARRAY POINTABLE 0-60 CROSS TRACK (ONE SIDE)

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Code: GDCD 0184

PAYLOAD ELEMENT SYNTHESIS

INSTRUMENT CLASSES	ATMOSPIL	ATMOSPUC	GLOBAL TOW	OCEAN ON	SEEAN CON MICS -	HYDRO.	BIOGEOCH	BIOMASE DY.	Simple LAND CO.	CONTINER DYNAMIC	100 mg
VIS/IR MODERATE & WIDE FOV IMAGERS		X	X	X		x	X	X	X	X	
VIS/IR HIGH RESOLUTION IMAGERS						X	x	X	X	x	
LASER RANGERS/ALTIMETER			i		X			X	X	х	
LIDAR FACILITY	x	x	x	X		x	X			x	
PASSIVE CHEMICAL SPECIES SENSORS	x		X				x				
MICROWAVE RADIOMETERS		x	X	X	X	x	X				
IR & MICROWAVE SOUNDERS	X	x	X			x					
SCATTEROMETERS		x	X	X	X	×	l '				
REAL APERTURE RADARS	b	X	x	X		x					
SYNTHETIC APERTURE RADARS					X	x		x	X	x	
SOLAR SENSORS	х		አ								
DATA COLLECTION LOCATION PLATFORM		x	x	x	X	x	x	X	x	X	

266.592-421

Instrument Use Matrix

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Code: GDCD G184

PAYLOAD ELEMENT SYNTHESIS

Table 0184-3 .

CONFIGURATION SIZING-ATTACHED MODE

POWER AND MASS ESTIMATE

	CONTIN		SPECIA	
SUB SYST EM	MASS (kg)	POWER (kw)	MASS (kg)	POWER (kW)
TELECOM POWER COMMAND/DATA DATA STORAGE AACS PROP (DRY) STRUCTURE, CABLING, THERMAL CONTROL PAYLOAD TOTAL:	0 25 150 142 0 0 950 2325 3,592	0 0 0.75 0.50 0 0.50 3.16 4.91	0 174 150 142 0 0 2700 7500 10,666 3,592 14,253	0 0.75 0.50 0 1.0 32. 34.25 4.91 39.16 (Use
				40 KW)

- NOTES:
 (1) Provided by Space Station
 - (2) Power distribution at 5 kg/kW

Section 1.3

Discipline	Environmental	Observations

GDCD ID NO.	PAYLOAD ELEMENT NAME
	WEATHER/CLIMATE
0201	Satellite Doppler Meteorological Radar Technology Development
0202	Meteorology Instrument Group Development Payload
0203	Lightning Mapper
0204	Geosynchronous Microwave Sounder
0205	Meteorology Instrument Group Operations Payload
0206	Geostationary Operational Environmental Satellite (GOES) Follow-on
0207	TIROS Follow-on
	OCEAN
0221	Ocean Instrument Payload (OIP)
0222	Ocean Topography Experiment (TOPEX)
	SOLAR TERRESTRIAL
0241	Earth Radiation - Budget Experiment (ERBE)
0242	Incoherent Scatter Radar
0243	Topside Digital Ionosonde/HF Radar
0244	Solar Terrestrial Observatory - Advanced
0245	Space Plasma Physics Payload - Advanced
0246	Solar Terrestrial Observatory
0247	Space Plasma Physics Payload
	ATMOSPHERIC RESEARCH
0261	High Resolution Doppler Imager (HRDI)
0262	Measurement of Air Polution from Satellites (MAPS)
0263	CO2 LIDAR for Atmospheric Trace Gas Concentration and Wind Velocity Transport Measurements
0264	LIDAR Facility
0265	Upper Atmosphere Research Payload-Development
0266	WINDSAT
0267	Upper Atmosphere Research Payload-Operational

		Page 1 of 3
		1
SAT DPLR Meteorolog Radar Tech	6 0 c 0 0 2 0 1	× ×
CONTACT W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division		Applications (non-commercial)
Audross P.O. Box 85357 San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Technology
Operational Planned		Operations
	nattu	Type Number 3
First flight, yr 1999		(see Table A)
Duration of Flight, days 365		Importance of the Space Station to
OBJECTIVE Develop enabling technology required for pushbroom	ed for pushbroom	
doppler radar measurement of global rainfall rates and ocean sur- face wind vector associated with storm systems and other special		1 = low value but
meteorological features. Evaluate techniques using mm waves provide 3-dimensional definition of nonprecipitating clouds.	Ising mm waves to	Could use 10 - vital
		Scala 1 - 10 9
DESCRIPTION		
A multifrequency spaceborne meteorologica, radar will be assembled for in-orbit operations in a modular form so that different and/or additional receiver channels and antenna beams can be implemented as the experiment matures toward a proof-of-concept design for potential operational use. Measurements will be made of cloud thickness and height, rain rate, and wind velocity. The phased-array antenna will be assembled by EVA in a modularized form and attached to the space station for development testing and trial operations.	r will be assenbled nal receiver channe proof-of-concept de thickness and heighled by EVA in a mochol trial operations.	for in-orbit operations in els and antenna beams can be sign for potential operathr, rain rate, and wind velularized form and attached

CODE G D C D D C D D C D D C D C D C D C D C
ORBIT CHARACTERISTICS Apogee, km 400 Tolerance + 33 100 100 Inclination, deg 57 Tolerance + 33 2 28.5 Nodal Angle, deg Ephemeris Accuracy, m Ephemeris Accuracy, m
TING/ORIENTA direction
Pointing accuracy, arc sec 3600 Field of view, deg ±30 Nadir Pointing Stability (Jitter) arc sec/sec Knowledge of Pointing ±6 arc sec
DAC DEC HOWER,
Standby 100 Continuous Peak
UNICATIONS grequirements! \[\times \
Data Types: Analog EDigital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) Downlink Frequency (MHZ)

ORIGINAL PAGE 19 OF POOR QUALITY

Crew Size Crew Size Crew Size Skills (See Table B) EUA SERUICING/MAINTENANCE SERUICE: Interval, days CONFIGURATION CHANGES: Interval, day Consumables, kg Consumables, kg Acceleration ansitivity, g min max Task Assignment Task Assignment Select Instruments/Data Analysis School Skill Ars/Day Consumables, kg Returnables, kg
SKILL 4 5 SKILL 3 2 LEVEL 3 2 Hrs/Day 0.2 0.2 Reason Assemble Antenna Hrs/EUA 24 Sg 180 Consumables, kg 8 Interval, day 180
SKILL 4 5 LEVEL 3 2 Hrs/Day 0.2 0.2 Reason Assemble Antenna Hrs/EUA 24 S 180 Consumables, kg Kg Man Hours Man/Hrs Rog.
Hrs/Day 0.2 0.2 Reason Assemble Antenna Hrs/EUA 24 s 180 Consumables, kg Han Hours Han/Hrs Rog.
S 180 Consumables, kg Man/Hrs Roq.
kg Man Hours kg 8 180 Consumables, kg 8 180 Man Hours Man/Hrs Roq.
Interval, day 180 Man/Hrs Req.

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

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G	OCO CODE 0201 ELEME	NT NAME SATEL	ITE TOP	PLER METEOR	ROLOGICAL	RADAR	TECH.
A	COMODATION: X ATTACHED	FREE FLYER	or	v ops			
1.	STATION ACTIVATION (E.G., SET-UP/A	ASSEMBLY/ATTACH	MENT AND	CHECKOUT)			
	DATE(S) 1999 INT. HRS	EVA HR	s <u>16</u>	EVA CREW	2		
	□ NOT APPLICABLE			_			
2.	SERVICE (E.G., REPLENISH/RESUPPLY	()					
	INTERVAL 180 DAYS TOTAL	SERVICES1_	 ,	•			
	TMS/OTV REQUIRED		TATION HE	S PER SERVICE	_4	•	
	□ NOT APPLICABLE		VA HRS PE	R SERVICE	4		
		i	VA CREWS	SIZE	1	•	
3.	STATION OPERATIONAL SUPPORT (A	VG. TIME FOR MON	IITOR, INSP	ECT, ETC.)			
	HRS PER DAY (INTERNAL)					
	HRS FER DAY (EVA)						
	☐ NOT APPLICABLE						
4.	RECONFIGURATION						
	INTERVAL 180 DAYS TOTA	L RECONFIGS1					
	TMS/OTV REQUIRED	S	TATION HR	S PER RECONFIG	i. <u>4</u>		
	☐ NOT APPLICABLE	E	VA HRS PEI	RECONFIG	4		
		E	VA CREW S	ZE _	1		
5.	DEACTIVATION/REMOVAL						
	DATE(S) 2000 INT. HRS	EVA HRS		_ EVA CREW _			
	□ NOT APPLICABLE						
6.	NOTES (BRIEFLY DESCRIBE TASKS IN	1 THROUGH 5 ABO	VE)				
3	 Assemble large antenna Assume resupply of cryo 2 crew @ 0.2 hrs Assume additional equipments Station OPS 	-		·			

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 0201

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Satellite Doppler Meteoroligical Radar Technology

Department

Reference Documents:

1. Space Station NAAO Study Orientation Meeting Handout at NASA Headquarters 14-15 September 1982

2. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

This payload element was listed as a candidate technology development mission on Page 50 of Attachment A to Ref 1. The mission utilized a large (50m) phased array antenna that is assembled by EVA in a modularized form. Different and/or adcitional receiver channels and antenna beams can be implemented as the experiment matures towards a Proof-of-Concept design for potential operational use. Attachment to a Space Station would allow ease of modification of antenna and other radar components as experiments progressed.

Physical characteristics for the payload element were derived from Ref 2, P C-4, "Synthetic Aperture Radar." The antenna size was scaled up from 12.3m to 50m and the system mass was scaled up from 800 kg to 2,600 kg. The SAR system operating power of 6 kW was used.

An orbit inclination of 28 1/2 degrees is satisfactory for development missions, but more useful operational data would be obtained at 57 degrees or higher.

Launch data and mission duration were derived by GDC.

Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 0201

PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Earth Observations-Instrument Development

Experiment Title: Satellite Doppler Meteorological Rauar Technology Development

Mission Objectives: Develop enabling technology required for pushbroom Doppler radar measurement of global rainfall rates and ocean surface wind vector associated with storm systems and other meteorological features. Developmental techniques using millimeter waves will also be evaluated to provide three dimensional definition of non precipitating clouds.

Mission Description: A multifrequency spaceborne meteorological radar will be assembled for in-orbit operations in a modularized form so that different and/or additional receiver channels and antenna beams can be implemented as the experiment matures towards a Proof-of-Concept design for potential operational use.

Benefit: Measurement of cloud thickness and height, rain rates, and winds within cloudy environments not accessible to other regions of the spectrum and on a global scale would have enormous benefit to meteorology, crop predictions, flood predictions, and related activities.

Justification: Testing of the pushbroom Doppler radar and its ability to make geophysical measurements using a low developmental cost modularized Add-On approach would allow a final cost effective instrument to be realized and at the same time quarantee its usefulness in operational applications.

Mission Requirements and Capability: A relatively large (50m) phased array antenna would be assembled by EVA in a modularized form. Attachment to space station (at least in initial configurations) would allow ease of modification of antenna and other radar components as experiments progressed. Space station would house the modularized electronics, data handling equipment, and primary power.

Space Station vs. Free Flyer: Space Station

TYPE
Applications (non-commercial)
Commercia
- Technology Development
Operations
Type Number
Importance of the Space Station to
DBJECTIVE Measure vertical profiles of atmospheric temperature and pres- sure and surface pressure for input to numerical weather Drediction models.
Scale 1 - 10 6
DESCRIPTION This payload is an integrated set of meteorological measuring instruments with supporting structure and subsystem for power, signals and thermal control interfaces. The following instructure and subsystem for power, Signals and Unit (AMSU); Advanced Moisture and instruments are included: Advanced Microwave Sounding Unit (AMS).
1 institution in the state of t

CODE 6 D C D O 2 O 2 O 3	of 3
Periges, km 400 Tolerance + Enhance + Enhance is Accus	
quired,m/s ENTATION On Inertial Solar X Earth	
360 Field arc sec/sec	
Bul	
lency, Hz	•
UNICATIONS grequirements! Realtime XOf ption/Decryption Requir Req.!Command Rate (K) and Data Processing Req	
Data Types: Analog NDigital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 3000 Downlink Frequency (MHZ)	

ORIGINAL PAGE 19 OF POOR QUALITY

C		T				T-				Τ-		
).2. Page 3 of		Stowed Deployed	1 1				12	٠	ka 4	1		frequencies. ition on optics.
G D C D D 2 D 2	X X X X X X X X X X X X X X X X X X X	2 0 d 4.4	I/U MBX	Monitor Data			Hra/EUA	ı	Man/Hrs Rog.		at least twice daily.	it their operating g and to condensa
	#1n 10	Remote d'A H.	itivity, g m	Task Assignment		0.2 0.2	Reconfig.	Consummbles,	90 kg	lons	al coverage at lea	AMSU and MPS are sensitive to microwave RF interference at their operating frequencies. AMTS is sensitive to IR emission, absorption or scattering and to condensation on optics AMTS, requires orientation with respect to velocity vector.
	Passive operational		mass, ables T ration	Task	SKILL	Hrs/Day	Ranson	06	NGEStInterval, day	/Sam Instructions	tions required for global coverage rowave RF energy.	ive to microwave cemission, absorp
) A ,	PHYSICAL OInter ID/Functi	Consum Consum Accele	REQUIREMENTS Siza	se Table B)		S ONO	G/MAINTENANCE Interval, days Returnables k	NGES 1	CONSIDERATIONS/500	<u>ح</u> ب	AMSU and MPS are sensit AMTS is sensitive to IR AMTS requires orientati
	THERMAL ————————————————————————————————————	EQUIPMENT Locationi Equipment		CREU REGU	Skills (Sag		EUA X YES	SERVICING/MAINTEN SERVICE Intorval, Returnabl	CONFIGURATION CHA	SPECIAL C	~~	(3) AMSU a AMTS is (4) AMTS r

Volume II, Book 1 Appendix I

GDCD CODE 0202 ELEMENT NA	METEOROLOGY INSTRUMENT GROUP DEVELOPMENT PAYLOAD
ACCOMODATION: X ATTACHED	FREE FLYER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEM	IBLY/ATTACHMENT AND CHECKOUT)
DATE(S) 1993 INT. HRS	EVA HRS EVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 90 DAYS TOTAL SERV	VICES 3
TMS/OTV REQUIRED	STATION HRS PER SERVICE
☐ NOT APPLICABLE	EVA HRS PER SERVICE 2
	EVA CREW SIZE 1
3. STATION OPERATIONAL SUPPORT (AVG. TI	IME FOR MONITOR, INSPECT, ETC.)
0.4 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	v
☐ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL 90 DAYS TOTAL REC	configs 3
☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIG. 2
□ NOT APPLICABLE	EVA HRS PER RECONFIG. 2
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) 1994 INT. HRS.	EVA HRS EVA CREW
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 TH	ROUGH 5 ABOVE)
 Station OPS Assume resupply of cryogeni 	ics
3. 2 crew @ 0.2 hours each	
 Assume adjustments station OPS 	•

GDC-ASP-83-002

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 0202

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Meteorology Instrument Group Development Payload

Reference Documents:

1. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP32-MSFC-253, March 1982.

Narrative:

This group of instruments was originally defined for the MSFC SASP. The instrument selection, size, weight, and power are all taken directly from Ref 1, Page D-1.

For developmental missions, the instruments can benefit from the availability of man for real-time monitoring and control, adjustments, repair, updating, and servicing.

A similar payload is envisioned for later operational use in a high inclination orbit, either in a manned or unmanned mode.

Launch data and mission duration were derived by GDC.

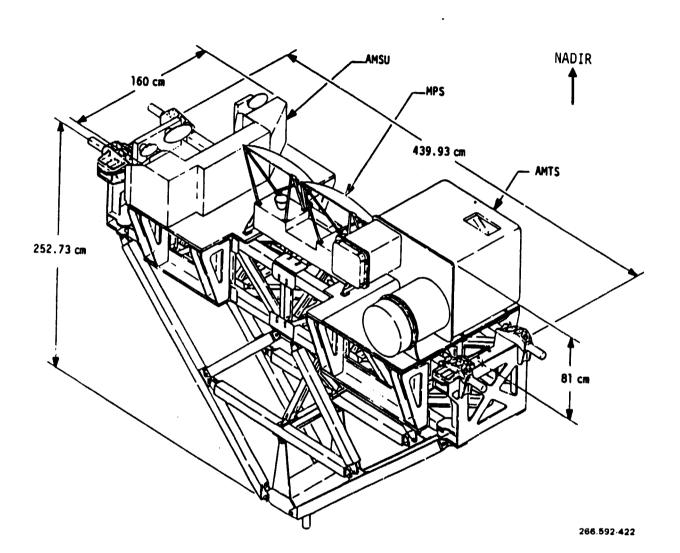
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GDC-ASP-83-002

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Code: GDCD 0202

PAYLOAD ELEMENT SYNTHESIS



ORIGINAL PAGE 19 OF POOR QUALITY

PAYLOAD ELEMENT NAME 6.0 C 0.2 0.3 TVI		7
	•	
M. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division	Applications (non-commercial)	
Hadross P.O. Box 85357 San Diego, CA 92138	Commercial	
Telephone (619) 277-8900, Ext. 3778/2130	Technology Development	
STATUS Descriptional	Operations	
Candidate Opportunity	Type Number	
First flight, yr 1998 No. of flights 1 mg 1460 Duration of Flight, days 1460	(see Table A) Importance of the Space Station to	
ightning in the overall environmental	this Element 1 - low calue but	
	could use 0 - vital	
S. S	Scale 1 - 10 3	
DESCRIPTION Sensors (spacecraft) will be deployed at five geosynchronous locations to measure the location and strength of lightning flashes. A continuous viewing (day and night) is required.	ions to measure the location night) is required.	

m					
CODE G.D.C.D.O.Z.O.3 Page 2 of 3	ORBIT CHARACTERISTICS Apogee, km 35,786 Tolerance + Inclination, deg 100 Tolerance + Nodel Angle, deg Ephemeris Accuracy, m Escape do Regulred, m/s	OINTING/ORIENTA low direction ruth Sites (if ointing accurac ointing Stabili	rating ndby k	23TA/COMMUNICATIONS Litering requirements: Noaltime Exother Liencryption/Decryption Required Uplink Req.: Command Rate (KBS) On-Board Data Processing Required Description	Data Types: Analog NDigital Hrs/Day Film (Amount) Live TV (Hrs/Day) Clos TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 2000 Downlink Frequency (MHZ)

ORIGINAL PAGE IS OF POOR QUALITY

C		·									
Page 3 of	1 1 1	p 8 A								Each	
		Stowed Deployed						Req.			
CODE 6 D C D 0 2 0 3	X X X X	2 E				Hrs/EUA		Man/Hrs Rog. Returnables,		along the	
ဝို့	X X X A A A	Remote Unpressurized 5 H.m 5 H.m 01tu, g min			:	Ŧ	bles, kg			are 5 spacecraft, approximately equally spaced along the orbit. OO kg.	
		Remote 12 H					Consumables,		5	tely equal	
-	nat ain nat sin nat ain nat ain	rics rnal surized Unpr U, m kg Types Types	Task A	X 1	Λe			day ka	ruction	approximat	
_	M Passive operational non-operational operational	CHARACTERISTICS nal External on Pressurized L,m 6 W,m L,m 6 W,m C,m 6 W,m Consumables Types Acceleration sensit	İ	SKILL	Hrs/Day	Ronson		NGESinterval, day Deliverables,	TIONS/5ee Instructions	cecraft,	
·	ິບຸ			0 8)		NO X	NANCE days	NGESI		are 5 spa 00 kg.	
	60	PHYSICAL CH Internation I ID/Function L,n C,n	REQUIREMENTS Sizo	(See Table	9	3	AMAINTE Intorval	TION CHA	ONSIDER	y. There weighs 90	
	THERMAL Active Temperature, de Heat Rejection,	EQUIPMENT Location: Equipment	CREU REQU	\$		EUA LIYES	SERVICING/MAINTEN SERVICE: Interval,	CONFIGURATION	SPECIAL CONSIDERA	Launch Only. There are 5 spacecraft weighs 900 kg.	

C - 4

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GDCD CODE 0203 ELE	MENT NAME LIGHT	NING MAPPER
ACCOMODATION: ATTACHED	T FREE FLYER	☑ OTV OPS
1. STATION ACTIVATION (E.G., SET-	UP/ASSEMBLY/ATTACH	IMENT AND CHECKOUT)
DATE(S) 1998 INT. HRS	EVA HR	S EVA CREW
☐ NOT APPLICABLE		
2. SERVICE (E.G., REPLENISH/RESUR	PPLY)	
INTERVAL DAYS TO	TAL SERVICES	
TMS/OTV REQUIRED		STATION HRS PER SERVICE
NOT APPLICABLE		EVA HRS PER SERVICE
	i	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT	T (AVG. TIME FOR MON	IITOR, INSPECT, ETC.)
HRS PER DAY (INTERN	IAL)	
HRS PER DAY (EVA)		
NOT APPLICABLE	•	•
4. RECONFIGURATION		
INTERVAL DAYS TO	OTAL RECONFIGS	
TMS/OTV REQUIRED	s	TATION HRS PER RECONFIG.
☑ NOT APPLICABLE	E	VA HRS PER RECONFIG.
	Ε	VA CREW SIZE
5. DEACTIVATION/REMOVAL		
DATE(S)INT. HRS.	EVA HRS	EVA CREW
▼ NOT APPLICABLE		
6. NOTES (BRIEFLY DESCRIBE TASK	S IN 1 THROUGH 5 ABO	OVE)
5. Operations continue	after year 2000	

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 0203

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Lightning Mapper

Reference Documents:

1. Space Station NAAO Study Orientation Meeting Handout, NASA Headquarters 14 15 September 1982.

2. MSFC MEMO PS06 (97) W.T. Carey to R. Bowman, GDC re: Lightning Mapper, 19 September 1980.

Narrative:

This payload element was included as a proposed modest initiative in Ref 1, P 8-20. Mission objectives and measurement requirements were listed in Ref 1, P 8-25.

The sensor system is a f/1.0 15cm aperture optical telescope with a low-light level TV detector. A pointing system is required that will yield an accuracy of 10 arc seconds and a stability of 1.0 arc second. Sensor system requirements were defined by Dr. Hugh Christian at the MSFC/SSL, and were transmitted to GDC with Ref (2).

This payload element description assumes that the sensor system is integrated with a small support spacecraft that provides attitude control, power, communications, and data handling, etc. (Wt. = 900 kg). AKM is not provided.

The spacecraft would by an OTV payload. Ideally, all five Lightning Mapper spacecraft would be emplaced by a single OTV flight.

Launch data and mission duration were derived by GDC.

EXAMPLE: LIGHTNING MAPPER

Measurements: Loc

Location and strength of lightning flashes

Objectives:

Determine the role of lightning in the overall

environmental system

Special Needs:

Continuous viewing, day and night sensitivity

Impacts:

Orbit

Solution:

Geosynchronous (5 Locations)

ORIGINAL PAGE IS

GDC-ASP-83-002

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Code: GDCD 0203

PAYLOAD ELEMENT SYNTHESIS

Resty to Attn of: PS06 (97)

September 19, 1980

Dr. Bob Bowman
General Dynamics/Convair Division
P. O. Box 80847
Mail Zone 21-9504
San Diego, CA 92138

SUBJECT: Lighning Mapper

As you know the Lightning Mapper Sensor System has been identified by NASA Headquarters OSTA as a candidate payload for the Experimental Geostationary Platform. The attached data sheet, developed by Dr. Hugh Christian of MSFC/SSL, describes the system as it is currently known. It was previously thought that the system would be comprised of both an RF and an optical system, however, the RF element has now been dropped. This was done because of the current belief that RF lightning emissions will be in wavelengths too long to penetrate the earths atmosphere to a measurable amount.

If further information on this system is needed please call me and we can set up a teleconference.

William T. Carey

Chief, Applications Group

Info cc: MTC-3/Mark Nolan NASA Hq/Bill Bishop

ES81/Bill Vaughan ES83/Hugh Christian EC/Wayne Wagnon GDC -ASP-83-002

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Code: GDCD 0203

PAYLOAD ELEMENT SYNTHESIS

CHARACTERISTICS OF STRAWMAN

LIGHTNING MAPPER SENSOR SYSTEM

Telescope:

f/1.0 15 cm. aperture (5 km resolution)

Pointing:

Platform - Earth pointing with accuracy of ~±0.05° Sensor System -Accuracy +10.0 sec (continuous) Stability + 1.0 sec (continuous)

Power:

150 watts

Weight:

Sensor - 60 kg Pointing System - 80 kg

Volume:

2 m³

Data Rate:

4.2 MHz Video 2 mb/s (continuous)

Temperature:

System - 0-40 C Detector Control - TBD

Consumables:

TBD

Uplink for Hybrid r f -Optical System:

100 kb/s

These figures assume that the platform provides:

- Power
- 2) Telemetry

Limited interruption of operation is tolerable; however, it will result in loss of real time and statistical data.

		Page 1 of 3
PAYLOAD ELEMENT NAME Geosynchronous Microwave Sounder	CODE G D C D O 2 O 4	•
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division	uc	Applications (non-commercial)
		- Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Technology Decelorate
Operational	Planned	Upperations
	Opportunity	
First flight, yr 1999 No. of flights 1 Duration of Flight, days 1500		(See Table A) Importance of the
		ب
All weather time variation of atmospheric temperature structure, mositure, and surface temperature		_ 0
		10 - vital
		Scale 1 - 10 7
DESCRIPTION		
A large antenna (33 m dia.) is used to measur atmosphere. Operating frequency image is 1 G provided by a MMS or Leasecraft type of bus.	nna (33 m dia.) is used to measure microwave emissions of land, ocean, and Operating frequency image is 1 GHz to 150 GHz. Housekeeping functions can be a MMS or Leasecraft type of bus. Transfer to GEO using a low thrust OTV.	s of land, ocean, and ekeeping functions can be ng a low thrust OTV.

C					
G D C D O 2 O 4 Page 2 of 3			Continuous	. (дна) Л	HZ)
CODE 6,0,0,0	Tolerance + Ephemeris Accuracy, m	Eisld of view, deg	Duration, hrs/day	Other Frequency (MHZ)	Voice (Hrs/Day) Voice (Hrs/Day) Other Downlink Frequency (MHZ)
	rigee, km 35,786	rtial Solar oc 20 ttor)arc sec/sec	reguen	ents: Of altime Oof yption Requir mand Rate (Ki rocessing Rec	Analog Digit (MBIT) ncy (Per Orbit) KBPS)
	Apogee, km 35,786 Perion Inclination, deg Variation, deg Variation, deg Variation deg Variation deg Variation de variation	OINTIN iew di ruth S ointin ointin	ODER AC CONTROL CONTRO	MUNICATION Part Part Part Part Part Part Part Part	Data Types: A Film (Amount) Live TU (Hrs/Day) On-Board Storage Data Dump Frequent

0	G D C D O 2 O 4	c
THERMAL ———————————————————————————————————		רם .
0-7	Stowed	
1	NBX	
Skills (See Table B) SKILL LEVEL Hrs/Day		
EUA XYES NO Reason Antenna Deploy Hrs/Fue	40	
Consumables, Man Hours	Roq	
LEO.	RA TEOLOGY XB	

Volume II, Book 1 Appendix I

GDCD CODE 0204 E	LEMENT NAME	GEOSYNCH	IRONOUS	MICROWAVE	SOUNDER
ACCOMODATION: ATTACH	ED 🗵 FREE	FLYER	∑ 0TV ()PS	
1. STATION ACTIVATION (E.G., SE	T-UP/ASSEMBLY	/ATTACHME	NT AND C	HECKJUT)	
DATE(S) 1999 INT. HR	s	EVAHRS_	40	_ EVA CREW _	1
		_		-	
☐ NOT APPLICABLE					
2. SERVICE (E.G., REPLENISH/RES	UPPLY)				
INTERVAL 800 DAYS 1	TOTAL SERVICES	1			
TMS/OTV REQUIRED		ST4	TION HRS	PER SERVICE _	16
□ NOT APPLICABLE		EVA	HRS PER	SERVICE _	
		EVA	CREW SIZ	Ε	
3. STATION OPERATIONAL SUPPO	RT (AVG. TIME	OR MONIT	OR, INSPEC	T, ETC.)	
	RNAL)				
HRS PER DAY (EVA)					
☑ NOT APPLICABLE					
4. RECONFIGURATION					
INTERVAL DAYS	TOTAL RECONF	IGS			
TMS/OTV REQUIRED		STA.	TION HRS P	ER RECONFIG.	
■ NOT APPLICABLE		EVA	HRS PER F	ECONFIG	
		EVA	CREW SIZE	· _	
5. DEACTIVATION/REMOVAL					
DATE(S) INT. HR	S (EVA HRS		EVA CREW	
		_		_	
☑ NOT APPLICABLE					
6. NOTES (BRIEFLY DESCRIBE TA	SKS IN 1 THROU	GH 5 ABOVE	E)		
 Antenna deployment Assume service in s 		ent			
5. Operation continues	after year	2000			

Page 1 of 4 Volume II, Book 1 Appendix I

Code: GDCD 0204

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Geosynchronous Microwave Sounder

Reference Documents:

- 1. Space Station NAAO Study Orientation Meeting Handout NASA Headquarters, 14 15 September 1982.
- 2. MSFC Memo PSO6(90), 28 August 1979. Re: Space Science Payloads for the Geostationary Platform.
- 3. JPL Report 710-12, pp 5-2 and 7-10

Narrative:

This payload element is listed as an example of an advanced meteorological remote sensor in Ref (1), Pg. 8-31.

The operational and physical characteristics of the sounder were taken from the description furnished by MSFC for the Geostationary Platform Study, Ref (2).

A 33 m diameter antenna suitable for operation up to 150 GHz was chosen. This requires a precision surface ($E = 0.035 \, \text{mm}$ RMS). The antenna consists of 30 high-precision gore sections assembled and aligned at LEO. Antenna weight is estimated to be 3.000 kg, based on Ref (3).

The antenna and mission electronics are mounted on a standard support bus. A spacecraft weight statement is given in Table 0204-1.

The spacecraft is transferred from LEO to GEO by a low thrust OTV.

Launch data and mission duration were derived by GDC.

Page 2 of 4 Volume II, Book 1 Appendix I

Code: GDCD 0204

PAYLOAD ELEMENT SYNTHESIS

EXAMPLE: Geosynchronous Microwave Sounding

Measurement: Microwave

Microwave emissions of land, ocean, and atmosphere

Objectives:

All weather time variation of atmospheric temperature

structure, moisture, and surface temperature

Special Needs:

Large antenna (>25m diameter)

Impacts:

Structure, orbit

Solution:

Large spacecraft

Page 3 of 4 Volume II, Book 1 Appendix I

Code: GDCD 0204

PAYLOAD ELEMENT SYNTHESIS

MICROWAVE SOUNDER

Objectives

- 1. General purpose receiving system for cm and mm wavelength emisions from the Earth and Sun.
- 2. Global mapping of atmospheric constituents such as precipitable water vapor.
- 3. Mapping of dispersion patterns of certain atmospheric pollutants with emission lines in the mm.
- 4. Measurements of ocean surface perturbations.
- 5. Measurements of solar emissions in wavelength bands unaccessible from within the atmosphere.

Requirements:

- 1. 33 m steerable parabolic antenna with surface smoothness of a few tenths of a mm.
- 2. Pointing: 20 arc seconds
- 3. Receives: 1 GHz to 150 GHz
- 4. Power: 200w (exclusive of pointing and steering)
- 5. Electronics Volume: 0.5 m³ mounted with the antenna 0.5 m³ mounted seperately
- 6. Weight: 50 kg (exclusive of antenna)

Antenna (from JPL Report):

Transported to LEO in shuttle. Consists of 30 high-precision gore sections assembled and aligned to surface accy. of 0.035 mm rms. Graphite/epoxy structure. Weight: 3,000 kg.

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Code: GDCD 0204

PAYLOAD ELEMENT SYNTHESIS

TABLE 0204-1. Geosynch Microwave Sounder Weight Statement

	Weight (1b)
Structure	1,206
Power	1,009
The rma 1	70
Propulsion, drag	300
TTC	100
Attitude Control	420
Mission Electronics	220
Antenna, 33m	6,600
Propellant	2,972 (2,823 useable)
	12,897 lb. (5,850 kg)

$$\Delta V = Isp g ln \frac{ws}{we} = 230 \times 32.2 \times ln \frac{12,897}{10,074}$$

 $\Delta V = 1,830 fps$

Propellant supply is good for about seven years of operation at $\Delta v = 260$ fps per year. This allows about 55 fps per year for repositioning to different longitudes in addition to normal station keeping and momentum wheel unloading. Orbit transfer propulsion is not included.

	Page 1 of 3
Meteorology Inst Group Oper Pl	TYPE
W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division	A Science & Applications (non-commercial)
Addross P.O. Box 85357 San Diego, CA 92138	- Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Technology Development
STATUS Operational Deanned	Operations
Opportunity	Type Number
1200 IZ00	
Measure vertical profiles of atmospheric temperature and pressure and surface pressure for input to numerical weather prediction models. (This payload is to be a man-tended operational version of the space station development payload GDCD 0202.)	1 - low value but could use 10 - vital
S	Scale 1 - 10 5
DESCRIPTION This payload is an integrated set of meteorological measuring instruments with supporting structure and subsystem for power signals and thermal control interfaces. The folloiwng instruments are included: Advanced Microwave Sounding Unit (AMSU). Advanced Moisture and Temperature Sounder (MPS).	truments with supporting erfaces. The folloiwng . Advanced Moisture and

ORIGINAL PAGE IS OF POOR QUALITY

Periges, km 400 Tolerance	ION Ephemeris Accura ION rating	ONS rements! Realtime XOf scryption Requir Command Rate (Ki	a Types! Analog XDigital Hrs/Day # (Amount) B TU (Hrs/Day) Soard Storage (MBIT)	
ORBIT CHARACTER Apogee, km 400 Inclination, de	Nodal Anglo, deg Escape do Require POINTING/ORIENTAT Ulew direction Truth Sites (if k Pointing accuracy Pointing Stabilit	Operation of the second of the		Data Types Film (Amoun Live TU (Hr On-Board St

5. Page 3 of 3		Stowed Deployed				ka	1	requencies. Lion on optics.
CODE G.D.C.D.O.2.0.5	10 = = = = = = = = = = = = = = = = = = =	35urizo H. 3 H. 3 2000			Hrs/EUA	summbles, Hours	meternismingungsgraftfier (flexible) en met fan fan fan fan fan fan fan fan fan fan	age at least twice daily. Prence at their operating f Scattering and to condensa
	Passive operational min non-operational min operational min non-operational min	ARACTERISTICS External Pressurized 1.6 U,m 1.6 U,m nch mass, kg sumables Types	•	SKILL LEVEL Hra/Dau		kg interval, day Deliverables, kg.		Continuous operations required for global coverage at least twice daily. MPS Radiates microwave RF energy AMSU & MPS are sensitive to microwave RF interference at their operating frequencies. AMTS is sensitive to IR emission, absorption or scattering and to condensation on optics.
	THERMAL DACTIVE DACTIVE DAGE C DE NOME DAGE C NOME DAGE NOME DAGE NOME DAGE DAGE DAGE DAGE DAGE DAGE DAGE DAG	EQUIPMENT PHYSICAL CHA Location; Internal Equipment ID/Function L,m L,m	CREU REQUIREMENTS Craw Siza	Skills (See Table B)	EUA TYES KAN	SERVICING/MAINTENANCE SERVICE: Interval, days Returnables, kg CONFIGURATION CHANGES: Interval,	SPECIAL CONSIDERATION	 Continuous operations required f MPS Radiates microwave RF energy AMSU & MPS are sensitive to micr AMTS is sensitive to IR emission

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GDCD CODE 0205 ELEMENT NAME METEOROLOGY INSTRUMENTS GROUP OPERATIONS PAYLOAD
ACCOMODATION: ATTACHED ATTACHED ATTACHED ACCOMODATION
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)
DATE(S) 1995 INT. HRS EVA HRS EVA CREW
□ NOT APPLICABLE
2. SERVICE (E.G., REPLENISH/RESUPPLY)
INTERVAL 700 DAYS TOTAL SERVICES 1
TMS/OTV REQUIRES ALTERNATE STATION HRS PER SERVICE 4
□ NOT APPLICABLE EVA HRS PER SERVICE
EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)
HRS PER DAY (EVA)
☑ NOT APPLICABLE
4. RECONFIGURATION
INTERVAL DAYS TOTAL RECONFIGS
☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG.
■ NOT APPLICABLE EVA HRS PER RECONFIG.
EVA CREW SIZE
5. DEACTIVATION/REMOVAL
DATE(S) 1999 INT. HRS EVA HRS EVA CREW
□ NOT APPLICABLE
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)
This payload element assumes accommodation on a platform or Leasecraft

type spacecraft which has orbit transfer propulsion.

2. Satellite service for propellant may be needed.

TOTAL EVA HRS	0
---------------	---

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Code: GDCD 0205

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Meteorology Instrument Group Operations Payload

Reference Documents:

1. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

This group of instruments was originally defined for the MSFC SASP. The instrument selection, size, weight, and power are all taken directly from Ref (1) p D-1.

For operational missions, a high inclination (57-90 degrees) orbit is required. Periodic manned servicing and updating will be required. Operational control and monitoring may be via remote links. The weight is for the integrated instrument package only and would require orbit transfer propulsion and supporting services such as provided by Leasecraft-type spacecraft or platform accommodation.

(This is an operational version of the payload element described in GDCD 0202.)

Launch date and mission duration were derived by GDC.

This payload element assumes accommodation on a platform or Leasecraft-type spacecraft which has orbit transfer propulsion.

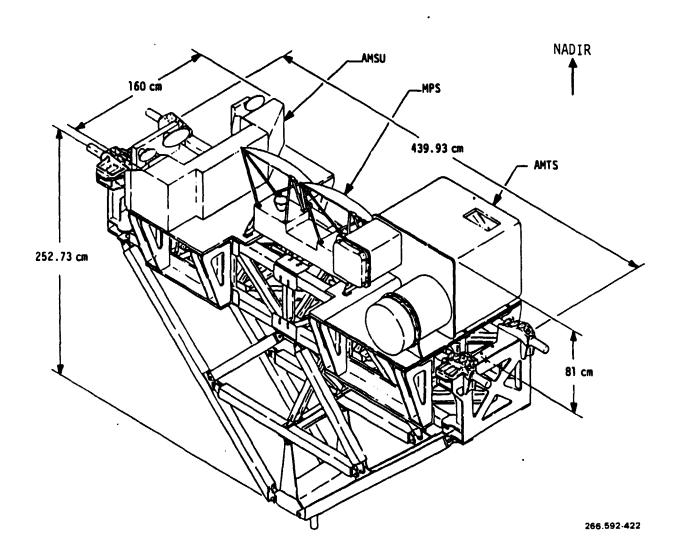
ORIGINAL PAGE TS

GDC-ASP-83-002

Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 0205

PAYLOAD ELEMENT SYNTHESIS



ORIGINAL PAGE 19 OF POOR QUALITY

	Page 1 of 3
PAYLOAD ELEMENT MAME GOES FOLLOW-On	
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division Address P.O. Box 85357	Applications (non-commercial)
San Diego, CA 92138 Telephone (619) 277-8900, Ext. 3778/2130	Commercial Technology
rational	Development
	Ture Number 3
ght, yr 1994 ights 1 of Flight, days >22	(see Table A) Importance of the Space Station to
OBJECTIVE Meteorological measurements and data relay.	this Eloment 1 - low value but could use 10 - vital
	Scale 1 - 10 3
DESCRIPTION Three satellites placed in different location in geostationary orbit. tional Environmental Satellite (GEOS) Follow-On	bit. Geostationary Opera-

ive Passive Passive Passive Passive Passive Passive Passive Physical CHARACTERISTICS Passive Pas
og C operational min non-operational min non-operational min ICAL CHARACTERISTICS
tion, w operational min non-operational min PHYSICAL CHARACTERISTICS
PHYSICAL CHARACTERISTICS
UInternal
Pressurized Unpressurized
2.2 H.m 2.2
nch mass, kg
Acceleration sensitivities a min
REOUIREMENTS
Craw Size
se Table B) SKILL
LEVEL
Hrs/Day
EUA YES X NO Remson Hrs/EUA
SERVICE: Interval, days Consumables, kg
kg Han Hours
Deliverables, kgReturnal
1
Launch Only. Three spacecraft in system; each weighs 500 kg on station (excludes AKM).

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GDCD CODE 0206 ELEMENT NAME	GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE
ACCOMODATION: ATTACHED THE FRE	EEFLYER @ OTV OPS (GOES) FOLLOW-OF
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBL	Y/ATTACHMENT AND CHECKOUT)
DATE(S) 1994 INT. HRS	EVA HRS EVA CREW
	-
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICE	es
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME	FOR MONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	• .
■ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECON	FIGS
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) 2000 INT. HRS.	EVA HRS EVA CREW
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROU	JGH 5 ABOVE)
5. Considered as debris removal.	

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 0206

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Geostationary Operational Environmental Satellite (GOES)
Follow-On

Reference Documents:

1. "GOES Executive Summary," Hughes Aircraft Co., May 1978

Narrative:

GOES is a component of the international World Weather Watch system. In this program, five geosynchronous orbit satellites supply continuous weather coverage of the Earth. Three GOES satellites operated by the U.S. are complemented by satellites operated by Europe and Japan.

The GOES Follow-on is an advanced version of GOES that could be launched from a space station OTV base. Remote servicing and repair in geosynchronous orbit are a potential role for a TMS that is transported by an UTV.

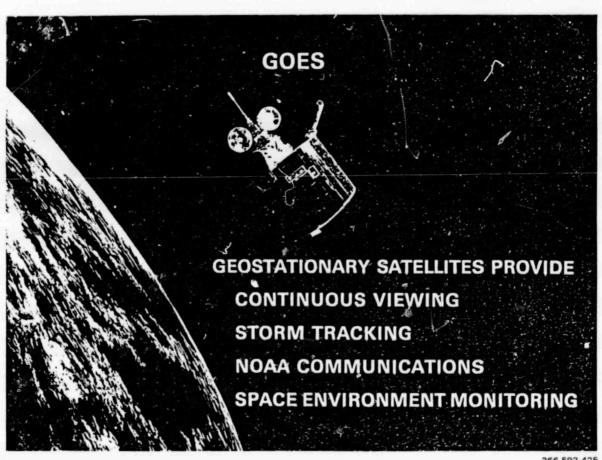
The physical characteristics are based upon those of the current GOES -D, -E and -F, excluding the apogee kick motor mass (Ref 1).

As an alternative accommodation mode, the meteorological instruments aboard GOES (Visible and IR spin scan radiometer atmospheric sounder, magnetometer, solar x-ray sensor, energetic particle detector, data relay system) could be installed on geostationary platforms.

Launch data and mission duration were derived by GDC.

Code: GDCD 0206

PAYLOAD ELEMENT SYNTHESIS



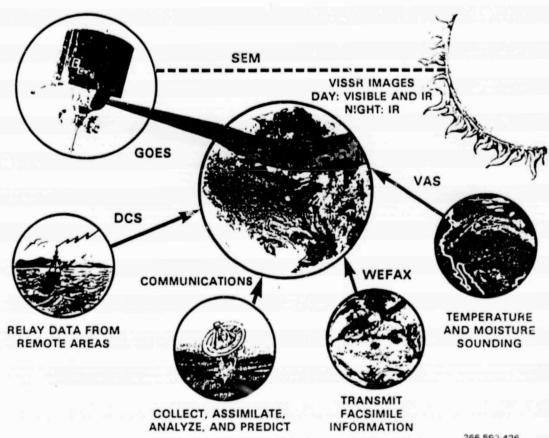
266.592-425

GOES

Code: GDCD 0206

PAYLOAD ELEMENT SYNTHESIS

ORIGINAL PAGE IS OF POOR QUALITY



The Role of GOES

266.592 426

	2400	Page 1 o
TIROS Follow-On	G D C D 0 2 0 7	
CONTACT		S X
~ .		Applications
San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Technology
STATUS		Jeval opnent
Operational Operational	pou	Operations
	Candidate Opportunity	Tupe Number
Wr 1992		(Soo Table A)
No. of flights 1 Duration of Flight, days >2900		Importance of the Space Station to
		ب
Meteorological measurements and data relay.		1 - low value but could use 10 - vital
		Scale 1 - 10
DESCRIPTION		
Satellite in Sun synchronous orbit.		

f 3			1		
Page 2 of 3			□ Continuous	-	
	, ,, ,		Cont	(BHZ)	
CODE G D C D O 2 0 7	+ 30	55		Frequency (MHZ)	Voice (Hrs/Day). Other ——— Downlink Frequency (MHZ)
CODE	Tolerance . ance + arls Accurac	th deg	irs/day	Freq	Day).
	Tolerance + Ephemeris Accuracy,	XEarth d of view.	Duration, hrs/day	Other	Hra/Day Hrs/Day) Other
	800 Tole Ephe	Field	W Durat		tal Voice Down
		Solar		Offiline squired	Oblattal U.
	Perigee, km 98 (Sun synch)	Inertial (un) rc sec (Jitter)arc	Power,		log Di
	Perics 98 Sun Sun	ATION Inertial known) Cy, arc sec ity (Jitter)a		ONS rements: Realtime scryption Red Command Rate a Processing	Analog (Day) rage (MBIT)
	SOO deg deg	CLC		ICATIONS requirem Ion/Decri Req.:Com d Data Pi	2 T T T Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z
: :	ORBIT CHARACTERI Apoges, km 800 Inclination, deg Nodel Angle, deg Escape d' Reguir	OINTING/ORIENTA 10w direction ruth Sites (if ointing accurac ointing Stabili	E A A	AMUN LAG LAG LAK BOBF	Data Types Film (Amou Live TU (H On-Board S Data Dump
	ORBIT Apoge Incli	POINTING Truth Sir Pointing Pointing	POUER OF SALES		

CODE G.D.C.D.O.2.O.7 Page 3 of 3	C operational min max non-operational min max operational min max non-operational min max max	CHARACTERISTICS Irnal External XRemote tion PressurizedXUnpressurize L,m 15 U,m 12 H,m Launch mass, kg Consumables Types		T.	day Man Hours Man/Hrs Req.	IONS/Sae Instructions
THERMAL	tiva re, deg C ction, w	PRACT DCA Sumab		SERVICING/MAINTENANCE	CONFIGURATION CHANGES Interval,	k.I

Volume II, Book 1 Appendix I

GOCD CODE 0207	ELEMENT NAME	TIROS FO	LLOW-ON	
ACCOMODATION:	ATTACHED FRE	E FLYER	OTV OPS	
1. STATION ACTIVATI	ON (E.G., SET-UP/ASSEMBL	Y/ATTACHMEN	T AND CHECKOUT)	
DATE(S) 1992	INT. HRS	_ EVA HRS	EVA CREW	
NOT APPLICA	BLE	-	*	
2. SERVICE (E.G., REP	LENISH/RESUPPLY)			
INTERVAL	DAYS TOTAL SERVICE	S	-	
TMS/OTV REC	LUIRED	STAT	TION HRS PER SERVICE	
☑ NOT APPLICA	BLE	EVA	HRS PER SERVICE	
		EVA	CREW SIZE	
	DNAL SUPPORT (AVG. TIME I DAY (INTERNAL)	FOR MONITO	R, INSPECT, ETC.)	
HRS PER				
■ NOT APPLICA				_
W HOT ALL EIGH	and the tea			
4. RECONFIGURATION				
INTERVAL	DAYS TOTAL RECON			
☐ TMS/OTV REO	UIRED		ION HRS PER RECONF	
■ NOT APPLICA	BLE		HRS PER RECONFIG.	
		EVA (CREW SIZE	
5. DEACTIVATION/RE	MOVAL			
DATE(S)	INT. HRS	EVA HRS	EVA CREW	
■ NOT APPLICA	BLE			
6. NOTES (BRIEFLY D	ESCRIBE TASKS IN 1 THRO	UGH 5 ABOVE	•	

5. Payload operation continues after year 2000.

GDC -ASP-83-002

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Code: GDCD 0207

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PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: TIROS Follow-On

Reference Documents:

1. Space Station NAAO Study, 14 & 15 September 1982 Orientation Meeting handout at NASA Headquarters

Narrative:

The TIROS/NOAA multi-mission sensing satellites provide daily (day and night) observations of the global weather. They collect data on atmosphereic temperature and humidity profiles, cloud coverage profiles, solar particles, ocean currents and temperatures, sea ice, and atmospheric/stratospheric conditions. Also, the NOAA series collects data from remote fixed or moving sensing platforms. Advanced satellites will also provide search-and-rescue (SAR) functions for ships and aircraft, ozone mapping of the atmosphere, and measurement of the incoming and outgoing planetary thermal radiation. Instrument complements (Ref 1) are listed on p 2 and indentified on p 3.

These satellites require near polar, sun-synchronous orbits. At least two must operate simultaneously.

These spacecraft will be shuttle launched into LEO. Self-contained propulsion systems are employed for orbit adjustments. An orbit transfer propulsion system is not included.

Launch date and mission duration were derived.

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Code: GDCD 0207

PAYLOAD ELEMENT SYNTHESIS

	LAUNCH DATE	AVHRR	HIRS-2	MSU	ssu	DCS	SBUV	ERBE	SEM	SAR
TIROS-N	10/78	•	•	•	0	•			•	
NOAA-A	6/79	•	•	•	0	•			•	
NOAA-C	8/81	•	•	•	0	•			•	
NOAA-D	10/81	•	•	•	☆	•			☆	
NOAA-E	5/83	•	•	•	Ō	•			•	•
NOAA-F	10/83	•	•	•	*	•	0	0	*	•
NOAA-G	5/85	•	•	•	0	•	0	0	•	•
NOAA-H	10/85	•	•	•	*	•	0	☆	*	
NOAA-I	5/87	•	•	•	0	•	o ·	☆	•	
L-AAON	10/87	•	•	• '	☆	•	Q.	☆	*	

266.592-427

NOAA Satellites Instrument Plan

[☆] SPACE, WT, POWER UNASSIGNED

^{*} POSSIBLE DOE NUCLEAR TESTING DEVELOPMENT DETECTOR IN PLACE OF SEM ON NOAA-F

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Code: GDCD 0207

PAYLOAD ELEMENT SYNTHESIS

NOAA Satellites Instruments (TIROS-N)

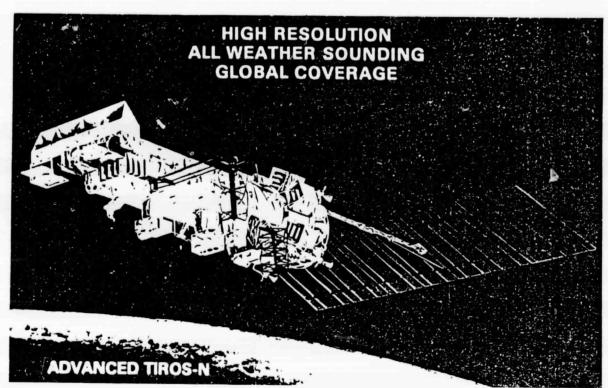
- AVHRR Advanced Very High Resolution Radiometer
 (Visible/IR with Field of View Imaging Radiometer)
- 2. HIRS-2 High Resolution Infra Red Sounder
- 3. MSU Microwave Sounding Unit
- 4. SSU Stratospheric Sounding Unit
- 5. DCS Data Collection System
- 6. SBUV Solar Backscatter Ultraviolet
- ERBE Earth Radiation Budget Experiment Scanner (Wide/Medium Field of View)
- 8. SEM Space Environment Monitor
- 9. SAR Search and Rescue

GDC-ASP-83-002

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Code: GDCD 0207

PAYLOAD ELEMENT SYNTHESIS



Low Earth Polar Orbiters Provide

266.592-428

Page 5 of 5 Volume II, Book 1 Appendix I

Code: GDCD 0207

PAYLOAD ELEMENT SYNTHESIS

As an alternative to the integrated spacecraft concept shown on page 4, the sensors could be accommodated or an instrument platform which is supported by a Leasecraft-type bus.

This would increase the mass to around 7000-8000 kg but would provide for much greater ΔV for orbit adjustments and for on-orbit servicing by the shuttle or TMS/space station.

	Page 1 of 3
Ocean Instrument Payload (OIP)	,
n MZ 21-9530 nvair Division	Applications (non-commercial)
San Diego, CA 92138	
Telephone (619) 277-8900, Ext. 3778/2130	Technology
	1 WB W do 1 B A B A
- Approved X Candidate	Uperations
	Number
First flight, yr 1994	(see Table A)
Duration of Flight, days 1825	Importance of the
To quantify patterns and variability of phytoplankton chlorophyll . Low value on a global scale develop and deploy sensors for detection of	" low value but
Ė	10 - vital
	Scale 1 - 10 9
DESCRIPTION	
The Ocean Instrument Payload (OIP) typically contains the scatterometer, ocean color imager, passive microwave radiometer and synthetic aperture radar, for deployment and operation. Altit contains the ocean microwave package (multibeam altimeter antenna and directional wave spectrometer) typical for check-out and evaluation for new ocean instrument techniques. Equipment could be externally mounted with a services interface to internal sources.	eter, ocean color imager, oyment and operation. Also a and directional wave strument techniques.

m					
CODE 6 D C D D 2 2 1 Page 2 of 3	300	±45 Nadir	Continuous	Frequency (MHZ)	(AHZ)
CODE 6, D, C, iges, km 500 Tolerance + Ephemeris Ac	ITATION I Dinertial Solar Earth f known) Laser acy, arc sec 1080 lity (Jitter)arc sec/sec	C Power, W Duration, hrs/day 10 10 Frequency, Hz	Offline Other Required to (KBS)	Analog EDigital Hrs/Day Jose (Hrs/Day) rage (MBIT) 1,000,000 rage (KBPS) Downlink Frequency (MHZ)	
	Apogee, km 500 Per Inclination, deg Nodal Angle, deg	NG/ORIEN Irection Sites (1 Ng accur ng Stabi	POUER AC NDC Operating 1200 Standby 120	UNICATI g requi ption/D k Req.:	Data Types! Ar Film (Amount) Live TU (Hrs/Day) On-Board Storage (Data Dump Frequence)

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GOCO CODE 0221 ELEMENT NAME OCEA	N INSTRUMENT PAYLOAD (OIP)
ACCOMODATION: ATTACHED S FREE FLYE	ER 🔲 OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	CHMENT AND CHECKOUT)
DATE(S) 1994 INT. HRS EVA	HRSEVA CREW
1999	
NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 730 DAYS TOTAL SERVICES 2	
X TMS/OTV REQUIRED ALTERNATE	STATION HRS PER SERVICE
□ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR M	ONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
☑ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONFIGS.	
TMS/OTV REGUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
·	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) 1999 INT. HRS EVA H	RS EVA CREW
2nd payload continues after 20	
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 A	ABOVE)
This payload element assumes accommodatype spacecraft which has orbit transf	ation on a platform or Leasecraft fer propulsion.
2. Satellite service for propellant m	

Page 1 of 1 Volume II, Book 1 Appendix I

Code: GDCD 0221

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Ocean Instrument Payload (OIP)

Reference Documents:

 Space Station NAAO Study Orientation Meeting Handout, NASA Headquarters, 14-15 September 1982

2. Science and Applications Requirements for Space Station, Draft, Provided 17 November 1982 at Interim Review at NASA Hq.

Narrative:

This payload was conceived to be two separate items - Ocean Color Imager (OCI) and Wind Scatterometer (SCATT) - as suggested in Ref (1). However, it seemed that the two might be combined into one payload as GDCD 0221 for study of the ocean surface characteristics. Other instruments were added to expand the instrument package. The sun synchronous orbit was chosen to accommodate the color imager, (Ref 1), pp 8-14, 8-17, and 8-28.

Data for the instruments and their requirements were obtained from Ref (2), paragraph 3.1.2.4.

The variety of instruments will drive the payload design as to potential mutual interference. The weight includes only the instrument package and would require a platform or Leasecraft-type bus to provide orbit transfer propulsion and support resources.

	Page 1 of 3
Ocean Topography Exp (TOPEX)	_
CONTACT W. Mardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division Address b b b b b b b b b b b b b b b b b b	Applications (non-commercial)
San Diego, CA 92138	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Technology Development
ופו	Operations
☐Approved ☐Opportunity	Type Number 3
First flight, yr 1988 No. of flights 1 Duration of Flight, days 3650	(see Table A) Importance of the Space Station to
OBJECTIVE	this Elonant
The ocean topography experiment (TOPEX) is to determine the general circulation (or current structure) of the global oceans. It is to advance the understanding of global ocean circulation, and provide an understanding of its wind driven component.	1 = low value but could use 10 = vital
	Scale 1 - 10 6
DESCRIPTION The TOPEX is a free-flyer containing instruments such as: radar altimeter with 2-cm precision measurement of ocean current structure, accelerometer for orbit determination to 10-cm accuracy laser retroflector, gravity, gradiometer, and 6-stick KU-band wind scatterometer (SCATT) While the TOPEX satellite may predate the sapce station, the space station could be used for on-orbit servicing thus extending the useful life of TOPEX by several years.	ltimeter with 2-cm precision etermination to 10-cm acand wind scatterometer (SCATT) e station could be used for eral years.

~)					
G.D.C.D.O.2.2.2.	5 5 0.2 ±0.1	±45 Nadir	Continuous	Fraquency (MHZ)		(MHZ)
3000 3000	km 1384 Tolerance + Ephemeris Ac	POINTING/ORIENTATION Use direction Incrtial Solar Searth Truth Sites (if known) Laser Pointing accuracy, arc sec 1440 Field of view, deg - Pointing Stability (Jitter) arc sec/sec Special Restrictions (Avoidance)	ا ا	UNICATIONS g requirements! —Realtime —Offline —Other ption/Decryption Required srd Data Processing Required Lption cem Monitor During Servicing	Data Typosi Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) 3000 Data Dum Frequency (Par Orbit)	Recording Rate (KBPS) 15 Downlink Frequency (MHZ)

ORIGINAL PAGE 19 OF POOR QUALITY

6		OF POOR QU	ALITY	
G D C D O 2 2 2 Page 3 of	X Passive ag C operational min 10 max 35 non-operational min -20 max 40 non-operational min max	PHYSICAL CHARACTERISTICS Internal External XRemote ID/Function PressurizedXUnpressurize L,m 6 U,m 5.5 H,m L,m 6 U,m 5.5 H,m Caunch mass, kg Consumables Types	SKILL LEVEL Hrs/Day Reason Reason Reason Hrs/EVA Interval, day Interval, day Deliverables, kg Boliverables, kg Returnables, kg peating ground track every 10 days spacecraft will be orbited prior e station will service only.	
	THERMAL	EQUIPMENT PH Locations [Equipment ID	CREW REQUIREMENTS Crew Size Skills (See Table B) Skills (See Table B) EUA	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GOCO CODE 0222	ELEMENT NAM	ME OCEAN	TOPOGRAPH	Y EXPERIMENT	(TOPEX)
	ATTACHED 🗵 F				
1. STATION ACTIVATION	E.G., SET-UP/ASSEME	BLY/ATTAC	MENT AND CH	ECKOUT)	
DATE(S) 1988	INT. HRS	EVA HR	s	EVA CREW	
NOT APPLICABLE				-	
2. SERVICE (E.G., REPLEN	ISH/RESUPPLY)				
INTERVAL 1000 DAY	'S TOTAL SERVI	CES3			
TMS/OTV REQUIR	ED	:	TATION HRS P	ER SERVICE	5
☐ NOT APPLICABLE		1	EVA HRS PER S	ERVICE	
		Į	EVA CREW SIZE		
3. STATION OPERATIONA	L SUPPORT (AVG. TIM	ME FOR MON	IITOR, INSPECT	, ETC.)	
HRS PER DA	Y (INTERNAL)				
HRS PER DA	Y (EVA)				
▼ NOT APPLICABLE					
4. RECONFIGURATION					
INTERVAL DAY	S TOTAL RECO	ONFIGS			
TMS/OTV REQUIR	EO	S	TATION HRS PE	R RECONFIG	
☑ NOT APPLICABLE		Ε	VA HRS PER RE	CONFIG.	
		E	VA CREW SIZE		
5. DEACTIVATION/REMOV	/ Δ Ι				
DATE(S) 1998		EV 1 HRS	£	VA CREW	•
		_ 57 (11110			
☐ NOT APPLICABLE		_			
6. NOTES (BRIEFLY DESCR	IIBE TASKS IN 1 THR	OUGH 5 ABO	IVE)		
 Initially launce Replacement of 	hed in 1988. attitude contr	rol and _l	propellant	s assumed.	

TOTAL EVA HRS 0

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Code: GDCD 0222

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Ocean Topography Experiment (FOPEX)

Reference Documents:

- 1. Space Station NAAO Study, 14 15 September 1892 Orientation Meeting Handout at NASA Headquarters.
- 2. Science and Applications Requirements for Space Station, Draft, Provided 17 November 1982 at Interim Review at NASA Hq.

Narrative:

The payload objective is to determine the general structure of ocean circulation currents.

The orbit is unique: 1384 killometers altitude, 63.4 deg inclination creating a 10-day cycle repeating ground track.

The payload will be launched prior to Space Station /TMS ERA (1990). The first Space Station-to-payload interface will be the servicing of the spacecraft, which does not contain orbit transfer propulsion.

The data were obtained from Ref (!), p 8-16, 8-24 and from Ref (2), paragraph 3.1.2.4.

*	Page 1 of 3
ME CODE	TYPE
lation Budget Exp	X Science L
W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division	
Addross P.O. Box 85357	
San Diego, CA 92138	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	- Technology
STATUS	
Operational OPlanned	Operations
⊠	
U Opportunity	•
First flight, yr 1991	~ 1
Duration of Flight, days 365	Importance of the Space Station to
OBJECTIVE	
To measure the amount and spectrum of thermal radiation from the Earth into space over a broad wavelength spectrum	1 = low value but could use 10 = vital
	Scale 1 - 10 5
DESCRIPTION Sensors for the Earth Radiation Budget Experiment (ERBE) are contained in two instrument packages, a wide and medium field of view (W/MFOV) unit and a scanner unit. The scanner unit contains three boresighted sensors (3° FOV), mounts facing Earth nadir, and scans	(ERBE) are contained in two and a scanner unit. The facing Earth nadir, and scans
	riewing the entire Earth disk, angle, and a solar viewing
cavity radiometer. This unit contains its own azimuth pointing gimbal. Later to become part of solar terrestrial observatory.	imbal.

n	· ·	7			
G.D.C.D.O.2.4.1 Page 2 of			□ Continuous	(2HW) A	(ZH
CODE 6,0,0,0	Tolera Tolerance + Ephemeris Acc	r XEarth Field of view, deg	W Duration, hrs/day	Other Frequency (MHZ)	tal Hra/Day Uoice (Hrs/Day) Other Downlink Frequency (MHZ)
	ORBIT CHARACTERISTICS Apogee, km 600/800 Perigee, km 600/800 Inclination, deg 46/98 Nodel Angle, deg Escape dV Required, m/s	POINTING/ORIENTATION Usew direction Inertial Solar Truth Sites (1f known) Pointing accuracy, arc sec Pointing Stability (Jitter) arc sec/sec Special Restrictions (Avoidance)	R Ac Do Power, Operating 60 Power, Standby Peak	DATA/COMMUNICATIONS Monttoring requirements: None Encryption/Decryption Required Uplink Req.:Command Rate (KBS) On-Board Data Processing Required Description	Data Types: Analog Digital Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 1.04

GODE 6.0.0.0.2.4.1. Page 3	9
1 min 10 max 35	
Heat Rejection, w operational min max	
S il Remota ized Unpressurize	
L'a L'a L'a L'a L'a L'a L'a L'a L'a L'a	
Acceleration sensitivity, a min max	
IREMENTS	Τ
Craw Size Task Assignment Observe Data	
Skills (See Table B) SKILL	
Hrs/Day	
EUA CYES NO Reason Hrs/EUA	
Stroice Interval, days Consumables, kg	Τ
NGESIInterval, day	T
Deliverables, kg Returnab	
at 98 deg. , 5-50 µm, and 0.2-50 µm. The ERBE scanner Anull has consistive to contaminants offertive	
within these spectral armost the control of the continuous operation is anticipated. Data is averaged on a monthly basis. Monthly sampling of the solar flux density is desired. Earth viewing sensors (wire-bound thermopiles) view internally during Junch and outgassing and view the son, space and internal black-body sources for periodic in-	
flight calibration.	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 0241 ELEMENT NAME	EARTH RADIATION BUDGET EXPERIMENT
ACCOMODATION: ATTACHED T FREE	FLYER
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY	ATTACHMENT AND CHECKOUT)
DATE(S) 1991 INT. HRS	EVA HRSEVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME F	OR MONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	•
■ NOT APPLICABLE .	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONF	IGS
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) 1992 INT. HRS	EVA HRS EVA CREW
NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH	GH 5 ABOVE)
This payload element assumes accom	
Leasecraft type spacecraft which	nas orbit transfer propulsion.
1. Two payloads ride piggyback or	o other P/L (2 different inclinations)

TOTAL EVA HRS 0

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 0241

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Earth Radiation Budget Experiment (ERBE)

Reference Documents:

- Space Station NAAO Study Orientation Meeting Handout, NASA Headquarters, 14-15 September 1982
- 2. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

This payload element was listed as an approved mission in development in Ref (1) p 8-20.

The instruments are required to be displayed on multiple spacecraft in different orbits to obtain a large number of observations uniformly in space and time.

The first instrument set will be launched aboard the Earth Radiation Budget Satellite (ERBS) in 1984. It will be shuttle launched (STS-17) into LEO. An orbit adjust propulsion system will raise the satellite into a 600 km, 46 deg inclined circular orbit.

Additional instrument sets will be launched in 1983 and 1985 aboard NOAA satellites.

In the 1990s, advanced instruments will be developed and will be employed on manned or unmanned platforms at high inclination. (46 deg and 98 deg).

Physical descriptions were taken from Ref 2, pp D-80 and -81. This payload element assumes accommodation on a platform or Leasecraft-type spacecraft which has orbit transfer propulsion.

Launch date and mission duration were derived.

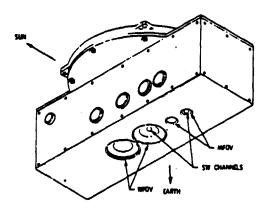
GDC -ASP-83-002

Page 2 of 3 Volume II, Book 1 Appendix I

Code: GDCD 0241

PAYLOAD ELEMENT SYNTHESIS

DESCRIPTION



MASS UP/DOWN (kg): 30/30 SIZE (m): $0.67 \times 0.25 \times 0.24$ POWER OP./PK.(kW): __0.017/TBD HEAT REJECTION: Passive DATA SCI./STAT.(kbps): 0.24G Total POINTING TYPE: Earth madir, solar ACC.()/STAB.(): TBD OPERATING COND: ___Continuous ORBIT (km/deg): 600/46 or SS polar FLIGHT DURATION (mo.): TBD

DESCRIPTION: Sensors for the Earth Radiation Budget Experiment (ERBE) are contained in two instrument packages, a Wide and Medium Field of View (W/MFOV) unit and a Scanner unit. The W/MFOV unit contains two madir pointing sensors (FOV ~130°) viewing the entire Earth disk, two madir pointing sensors (FOV ~75°) viewing a 10° Earth central angle, and a solar viewing cavity radiometer. This unit contains its own azimuth pointing gimbal.

EMISSIONS/SUSCEPTIBILITIES: ERBE W/MFOV measurement channels are 0.2-5 µm and 0.2-50+ pm. ERBE W/MFOV would be sensitive to contaminants effective within these spectral ranges.

OPERATIONAL REQUIREMENTS: Duty cycle of ERBE W/MFOV unit was not specified but continuous operation is anticipated. Data is averaged on a monthly basis. Monthly sampling of the solar flux density is desired. Earth viewing sensors (wire-wound thermopiles) view internally during launch and outgassing and view the sun, space and internal black-body sources for periodic in-flight calibration.

SPECIAL CONSIDERATIONS: ERBE objectives require simultaneous sampling of the radiation reflected from and switted by Earth. A minimum of two flight vehicles are needed, one in a 46°, 600 km orbit and the other in a high inclination orbit (polar midmorning or mid-afternoon pruferred).

CONTACT:

D. Miller, NASA Headquarters

REFERENCE: Handbook of Sensor Technical Characteristics, compiled for NASA OSTA by Systematics General Corp., September 1981.

0-80

Change No. 1* 8-16-82 266.592-429-1

Earth Radiation Budget Experiment

ORIGINAL PAGE 13 OF POOR QUALITY

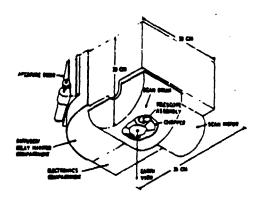
GDC -ASP-83-002

Page 3 of 3 Volume II, Book 1 Appendix I

Code: GDCD 0241

PAYLOAD ELEMENT SYNTHESIS

DESCRIPTION



MASS UP/DOWN (kg): 25/25 SIZE (m): $0.36 \times 0.33 \times 0.30$ POWER OP./PK.(kW): 0.035/TBD HEAT REJECTION: Passive OATA SCI./STAY.(kbps): 0.880 Total POINTING TYPE: Earth madir, solar ACC.()/STAB.(): TBD OPERATING COND: _Continuous ORBIT (km/deg): 600/46 or SS polar FLIGHT DURATION (mo.): TBD

DESCRIPTION: Sensors for the Earth Radiation Budget Experiment (ERBE) are contained in two instrument packages, a Wide and Medium Field of View (W/MFOV) unit and a Scanner unit. The Scanner unit contains three boresighted sensors (3° FOV), mounts facing Earth madir, and scans the sensors cross-track from horizon to borizon.

EMISSIONS/SUSCEPTIBILITIES: ERBE Scanner measurement channels are 0.2-5 µm, 5-50 μm , and 0.2-50 μm . The ERBE Scanner would be sensitive to contaminants effective within these spectral ranges.

OPERATIONAL REQUIREMENTS: The duty cycle of the ERBE Scanner unit was not specified but continuous operation is anticipated. Data is averaged on a monthly basis. The continuously rotating scan drum sequences each sensor (pyroelectric type) through the Earth scan, a deep space view, and either a black-body view (long wave and total bands) or a sun view (short wave and total bands).

SPECIAL CONSIDERATIONS: ERBE objectives require simultaneous sampling of the radiation reflected from and enacted by Earth. A minimum of two flight vahicles are needed, one in a 46°, 600 km orbit and the other in a high inclination orbit (polar mid-morning or mid-afternoon preferred).

CONTACT:

D. Diller, NASA Headquarters

REFERENCE: Handbook of Sergor Technical Characteristics, compiled for MASA OSTA by Systematics General Corp., September 1981.

D-81

Change No. 1* 8-16-82 266.592-429-2

Earth Radiation Budget Experiment (contd)

Radar 6 0 0 0 2 4 2	-
eterson NZ 21-9530 ics Convair Division	Applications (non-commercial)
San Diego, CA 92138	Commercial
one (619) 277-8900, Ext. 3778/2130	O Technology Development
nal Planned	Operations
Opportunity	Type Number 3
ght, yr 1996 ights 2 of Flight, days 365	Importance of the Space Station to
OBJECTIVE	his Eloment
To develop and operate from near-Earth space a UHF incoherent scatter radar for remote-sensing of Earth's upper atmosphere to determine its ambient behavior, and provide specific diagnostic support to active plasma physics experiment.	- low value but could use
738	Scale 1 - 10 6
DESCRIPTION Transmitter, receiver and computer are contained within the space station. The large antenna dish (25m when deployed) will operate in the UHF region of 300 - 3000 MHz band.	tation. The large antenna 100 MHz band.
•	

ORIGINAL PAGE 19 OF POOR QUALITY

E					
Page 2 of	0		□ Continuous -		
G D C D O 2 4 2	100	Viewing ±45 Nadir	Ö	Frequency (MHZ)	(MHZ)
CODE G D C	Tolerance + Ephemeris Accuracy,	XEarth and Sky Viewing of view, deg ±45 Nad	hrs/day	Freque	rs/Day rs/Day) isr Fraguency (MHZ)
	Told olerance phemeris	XEar Field of v	Duration, hrs/day	Other	Oth Oth Oth
	400		U L	XOffline squired s (KBS) s Required	116
	gee, km nd 90		Pouer,	XOf Requirate (Ki	or Or
	1STICS Periges, g 28.5 and 90 g m/s	ATION Inertial known) 18.0 (g, arc sec 18.0 (1.00 to 18.0 to 1	6711	IONS Lruments: MRealtime Decryption Re Command Rate ta Processing	osi Analog lount) (Hrs/Day) Storage (MBIT) P Frequency (Pe
	CHARACTERI S, kn 400 hation, deg Angle, deg	Ction ction es (if secura stric	Operating Standby Peak	DATA/COMMUNICATION Anitoring requirement of the control of the con	T D T C T C T C T C T C T C T C T C T C
	ORBIT CHARAC Apoges, kn Inclination, Nodel Angle, Escape do Re	0-1000	OUER	Monttoring Monttoring Monttoring Montank Descrip	PILLE CLVG ON-B Onta

ORIGINAL PAGE 19 OF POOR QUALITY

CODE 6,0,0,2	2.4.2. Page 3.6.3
THERMAL Passiva Passiva Temperature, deg C operational min 10 Passiva Temperature, deg C operational min 10 Passiva 10 Pass	35
non-operational operational	
S Remote	
L, m 4 C, m C, m C, m C, m C, m C, m C, m	Stowed
ables Types	0.2
IREMENTS	You
Craw Size Task Assignment Monitor	Monitor/Operate Equipment
5	
EUA X VES UNO Rouson Assy/Disassy Ant Hrs/EUA	16
SENCICE Interval, dags Consumables, kg Arturnables, kg	
STREET STREET	Rog.
kgReturnal	los, kg
lons	ı
Susceptible to RF noise background. Power capacity bank, head disipation and antenna size requirements as well as frequent man-machine interfacing. Two missions are desired, one a	nead disipation and antenna size Two missions are desired, one at an
inclination of zero degrees (28.5 acceptable) and one at 90 degree polar orbit. Second flight is in 1998.	oit. Second flight

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDC	CODE	0242	ELEMENT NAM	INCOHER	ENT SCA	TTER RADAR	<u> </u>
ACCO	MODATION:	₹ ATT	ACHED FF	EE FLYER	□ 0TV	OPS	
1. ST	TATION ACTIV	/ATION (E.G.	, SET-UP/ASSEMB	Y/ATTACHM	ENT AND	CHECKOUT)	
0/	ATE(S) 1996	5 INT.	. HRS <u>4</u>		4	EVA CREW	1
	•	3	4		4		1
	☐ NOT APPL	LICABLE					
2. SE	RVICE (E.G.,	REPLENISH/	RESUPPLY)				
			TOTAL SERVIC				
	TMS/OTV	REQUIRED_		STA	ATION HRS	S PER SERVICE	
	図 NOT APPL	ICABLE _		EV	A HRS PER	SERVICE	
				EA	A CREW SI	ZE	
3. ST	TATION OPER	ATIONAL SU	PPORT (AVG. TIM	E FOR MONIT	OR, INSPE	CT, ETC.)	
	0.5 HRS	PER DAY (IN	ITERNAL)				
	HRS	PER DAY (E	VA)				
	☐ NOT APPL	ICABLE					
4. RE	ECONFIGURA	TION					
IN	TERVAL	DAYS	TOTAL RECO	NFIGS.			
	☐ TMS/OTV	REQUIRED		STA	TION HRS	PER RECONFIG)
	☑ NOT APPL	ICABLE		EVA	has per	RECONFIG	
				EVA	A CREW SIZ	ZE _	· · · · · · · · · · · · · · · · · · ·
5. DE	EACTIVATION	/REMOVAL					
, מ	ATE(S) 199	7 INT.	hRS. 4	EVA HRS _4	1	_ EVA CREW _	1
	199	19	4		-		1
	☐ NOT APPL	ICABLE					
6. NO	OTES (BRIEFL	Y DESCRIBE	TASKS IN 1 THRO	UGH 5 ABOV	E)		
1. 3. 5.	Monitor/	operate o	plus statio equipment plus station				

Page 1 of 6 Volume II, Book 1 Appendix I

Code: GDCD 0242

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Incoherent Scatter Radar

Reference Document:

- 1. Space Station Missions Upper Atmospheric Research, Lewis M. Duncan, ESS-7, MS466 Los Alamos Nat. Lab., Received September 30, 1982.
- 2. L.M. Duncan, Telecon, February 18, 1982.

Narrative:

This mission was suggested by Dr. Lewis M. Duncan of Los Alamos National Laboratory (Ref 1).

The physical characteristics of the payload element were derived, based on similarity to other UHF radar equipment, and assuming a 25m diameter deployable antenna such as the deployable truss type.

This payload element has applications in several scientific disciplines; i.e., Atmospheric Physics and Plasma Physics.

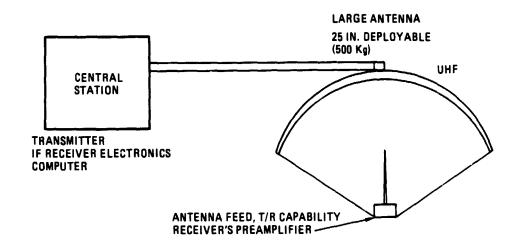
Launch date and mission duration were derived.

Crew time was averaged, over the life of the experment based on four hours per week per Ref (2).

Page 2 of 6 Volume II, Book 1 Appendix I

Code: GDCD 0242

PAYLOAD ELEMENT SYNTHESIS



266.592-430

Incoherent Scatter Radar

Code: GDCD 0242

PAYLOAD ELEMENT SYNTHESIS

INSTRUMENT:

INCOHERENT SCATTER RADAR

APPLICATIONS:

BASIC STUDIES OF UPPER ATMOSPHERE

(AERONOMY)

SOLAR - TERRESTRIAL RELATIONS

IONOSPHERE - MAGNETOSPHERE COUPLING

ACTIVE EXPERIMENTS IN SPACE PLASMAS

HF IONOSPHERIC MODIFICATION

CHEMICAL RELEASES

WAVE INJECTION

BEAM-PLASMA INTERACTIONS

266.592-431

Incoherent Scatter Radar (contd)

Page 4 of 6 Volume II, Book 1 Appendix I

Code: GDCD 0242

PAYLOAD ELEMENT SYNTHESIS

WHAT DOES AN INCOHERENT SCATTER RADAR DO?

HIGH SPATIAL- AND TEMPORAL RESOLUTION MEASUREMENTS OF:

ELECTRON DENSITY
ELECTRON & ION TEMPERATURES
IONOSPHERIC WINDS AND DRIFTS
ION COMPOSITION
PLASMA WAVE TURBULENCE

266.592-432

JUSTIFICATION:

LONG-DURATION, GLOBAL COVERAGE MISSIONS

LARGE POWER, CAPACITOR BANK, HEAT
DISSIPATION REQUIREMENTS

LARGE ANTENNA WITH POINTING REQUIREMENTS

ANTICIPATED MAN-MACHINE INTERFACING NEEDS

266.592-433

Incoherent Scatter Radar (contd)

GDC-ASP-83-002

Page 5 of 6 Volume II, Book 1 Appendix I

Code: GDCD 0242

PAYLOAD ELEMENT SYNTHESIS

INCOHERENT SCATTER RADAR

I. Mission Objectives

To develop and operate from near-earth space a UHF incoherent scatter radar for remote-sensing of the earth's upper atmosphere.

II. <u>Mission Description</u>

The proposed mission will provide worldwide observations of upper atmospheric morphology and dynamics through the monitoring of ionospheric electron densities, electron and ion temperatures, ionospheric drifts and background winds, ion composition, and plasma wave turbulence. Incoherent scatter radar has the advantage over in-situ passive plasma diagnostics in that it provides high-resolution observations of the ambient aerospace environment well beyond the local region disturbed by the instrumented vehicle. The radar can be used both for long-term global observations of the ambient upper atmospheric behavior, and for specific diagnostic support to active space plasma physics experiments such as HF radiowave modification of the ionosphere, wave and chemical injection experiments, and beam-plasma interaction studies.

III. Benefits

A space-based incoherent scatter radar would provide a multi-purpose, global-coverage diagnostic for research studies of the earth's upper atmosphere, with important potential contributions to the investigation of solar-torrestrial relations and in particular to ionosphere-magnetosphere coupling, to the study of communications dependence on the upper atmosphere, and to basic space plasma physics research exploiting the aerospace environment as a large, natural plasma laboratory-without-walls. Such an instrument might also find unique applications to specific radio astronomy observations.

IV. Justification

Virtually an unlimited number of aeronomy and space plasma physics experiments could be supported by a space-based incoherent scatter radar. Such a radar requires long-duration space deployments; large antenna, power source, capacitor bank, and heat dissipation capabilities; and for optimum flexibility, some level of man-machine interfacing. For specific experimental applications, event point tracking would be necessary.

Code: GDCD 0242

PAYLOAD ELEMENT SYNTHESIS

V. Mission Requirements and Capabilities

- (a) Orbital Parameters -- Both low inclination and near polar orbits are desirable. Orbital altitudes of 400-500 km are preferred.
- (b) Mass, Volume -- TBD, but a large (at least tens of meters) antenna can be anticipated.
- (c) Power -- The power requirements depend on a number of inter-related TBD parameters, including antenna size, capacitor bank and heat dissipation limitations, and desired radar transmitter pulsing characteristics and operational duty cycle.
- (d) Thermal Control -- TBD, but considerable heat dissipation requirements can be anticipated.
- (e) Attitude, Stabilization -- An earth-looking attitude is required. Pointing characteristics may in part be determined by the antenna size and resultant radar beamwidth.
- (f) Viewing -- An earth-viewing capability is required. For potential radio astronomy applications this may need to be extended to include full sky coverage.
- (g) Environmental Constraints -- TBD, possible RF noise background constraints.
- (h, i) Data Management, Communications, Crew Timeline -- For general atmospheric monitoring purposes, unmanned operation may be acceptable. However, for specific experimental observations, manned operation will be necessary for real-time data management.
- (j) Operations Schedule, Maintenance, Lifetime -- TBD.

VI. Space Station vs. Free Flyer

Power, capacitor bank, heat dissipation, and antenna size requirements, as well as probable frequent man-machine interfacing needs, determine this radar to be necessarily a space station mission.

20 1. 10 1. 11 1. 12 1. 12 1. 12. 12.

		Page 1 of
PAYLOAD ELEMENT NAME Tonside Digital Tonside Digital Tonsonde/HE Radar	CODE 6 0 C 0 0 2 4 3	
TODS THE DIGITAL TOTIOSOTIME IN MANAI		X Science &
CONTACT W. Hardy/J. Peterson MZ 21-9530		Applications
44.0		(101 102201101)
San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Technology
STATUS		
Operational Operational	pod	Operations
Approved XCandidate Opportuni	Candidate Opportunity	Tune Number
1997		(see Table A)
No. of flights 2 365		Importance of the Space Station to
		4
		1 " low value but could use 10 " vital
		Scale 1 - 10 9
DESCRIPTION		
Four 100-meter booms erected in right crusiform configuration about the spacestation. Each of the four elements are terminated in a HF receiving cross dipole. Both the plane of the dipole cross and the crusiform are normal to the local vertical. The HF transmitter, computer, and transmitting antenna are located on/in the space station body. Array will require assembly in orbit. Operating HF is 3-30 MHz.	orm configuration abou eiving cross dipole. cal vertical. The HF pace station body. An	tion about the spacestation. Each of lipole. Both the plane of the dipole. The HF transmitter, computer, and body. Array will require assembly

om mad to set the of Pode Conulty

C	<u> </u>			_	
CODE 6.0 C.0 0.2 4.3 Page 2 of 3	0	OINTING/ORIENTATION TIEM direction ruth Sites (if kointing accuracy ointing Stabilities pecial Restricti	Ing	UNICATIONS grequirements; [X]Realtime [Of ption/Decryption Require R Req.:Command Rate (K) and Data Processing Req	Data Types: Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

ORIGINAL PAGE 18 OF POOR QUALITY.

10
non-operational min max max operational min max max max mon-operational min max
EQUIPMENT PHYSICAL CHARACTERISTICS Location: Distance External Remote Equipment ID/Function Pressurized Unpressurized L,m 200 U,m 200 H,m 3 Deployed Launch mass, kg
ables Tration
Task Assignment Operate/Monito
Skills (See Table B) SKILL 5 LEVEL 2
Hrs/Day 0.5
EUA X VES
Consumm bles,
The man day
Deliverables, kgReturnables, kg
ons
Two missions are desired, one at an inclination of 0 degrees (28.5 deg. acceptable) and one at 90° polar orbit. Second flight is in 1999.

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GOCD CODE 0243 ELEMENT NAME TOPS	IDE DIG. IONOSONDE/HF RADAR
ACCOMODATION: ATTACHED	R OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	CHMENT AND CHECKOUT)
DATE(S) 1997 INT. HRS 4 EVA H	IRS _4 EVA CREW _1
1999 4	_4
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MI	ONITOR, INSPECT, ETC.)
0.5 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
□ NOT APPLICABLE	
4. RECONFIGURATION	,
INTERVAL DAYS TOTAL RECONFIGS.	
☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
E OCACTIVATION/DCMOVAL	
5. DEACTIVATION/REMOVAL	no A eva open 1
DATE(S) 1998 INT. HRS. 4 EVA HI	
20004	_41
_	86451
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 A1. Assemble Antenna plus station OPS	RUAF)
3. Operate/monitor data 5. Remove Antenna plus station OPS	

Page 1 of 6 Volume II, Book 1 Appendix I

Code: GDCD 0243

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Topside Digital Ionosonde/HF Radar

Reference Documents:

- 1. Space Station Missions Upper Atmospheric Research, Lewis M. Duncan, ESS-7, MS466 Los Almos Nat. Lab., Received September 30, 1982.
- 2. L.M. Duncan, Telecon February 18, 1982.

Narrative:

This mission was suggested by Dr. Lewis M. Duncan of Los Alamos National Laboratory (Ref 1).

The physical characteristics of the payload element were derived, based on the use of graphite-epoxy expandable boom technology.

This payload element has applications in several scientific disciplines; i.e., Atmospheric Physics, Plasma Physics, and Radio Astronomy. It also has potential as a surveillance radar.

Scientific objectives would benefit most from high or polar inclination orbits.

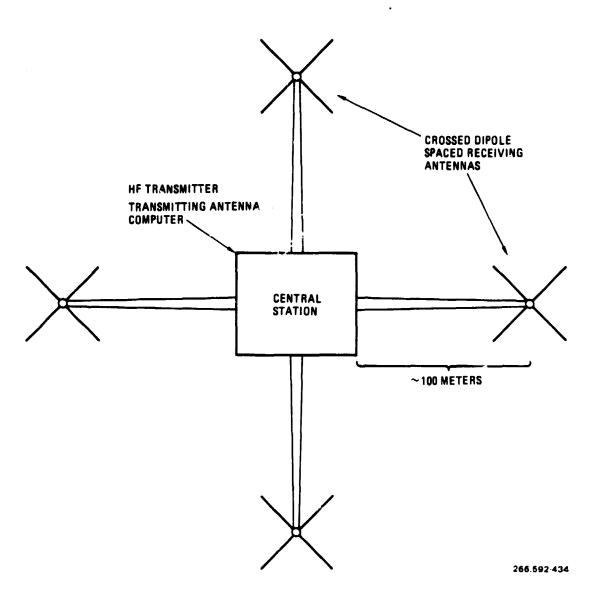
Launch date and mission duration were derived.

Crew time was averaged over the life of the experiments based on four hours per week per Ref 2.

Page 2 of 6 Volume II, Book 1 Appendix I

Code: GDCD 0243

PAYLOAD ELEMENT SYNTHESIS



Topside Digital Ionosonde/HF Radar

Page 3 of 6 Volume II, Book 1 Appendix I

Code: GDCD 0243

PAYLOAD ELEMENT SYNTHESIS

INSTRUMENT:

TOPSIDE DIGITAL IONOSONDE / HF RADAR

APPLICATIONS:

BASIC STUDIES OF TOPSIDE IONOSPHERE

SOLAR-TERRESTRIAL RELATIONS

IONOSPHERE-MAGNETOSPHERE COUPLING

HF RADIO ASTRONOMY

SURVEILLANCE

266.592-435

Topside Digital Ionosonde/HF Radar (contd)

Code: GDCD 0243

PAYLOAD ELEMENT SYNTHESIS

WHAT DOES A TOPSIDE DIGITAL IONOSONDE / HF RADAR DO?

HIGH SPATIAL- AND TEMPORALRESOLUTION MEASUREMENTS OF:

TOPSIDE IONOSPHERE ELECTRON DENSITY

LARGE SCALE STRUCTURE

(MORPHOLOGY)

MEDIUM SCALE STRUCTURE
(ACOUSTIC-GRAVITY WAVES)

SMALL SCALE STRUCTURE /TURBULENCE (SPREAD F)

TOPSIDE VERTICAL LAYER MOTIONS

266.592-436

JUSTIFICATION:

LONG-DURATION, GLOBAL COVERAGE MISSIONS
SCIENTIFIC
SURVEILLANCE / NATIONAL SECURITY

LARGE ANTENNA ARRAY

266.592-437

Topside Digital Ionosonde/HF Radar (contd)

Code: GDCD 0243

PAYLOAD ELEMENT SYNTHESIS

DIGITAL TOPSIDE IONOSONDE/HF RADAR

I. Mission Objectives

To develop and operate from near-earth space on HF digital topside ionosonde/HF radar.

II. Mission Description

The proposed mission will provide worldwide observations of upper atmosphere/ionosphere morphology and dynamics through the monitoring of topside ionospheric electron densities and structure motions. HF ionosondes have the advantage over in-situ passive plasma diagnostics in that they provide high-resolution observations of the ambient space environment well beyond the local region disturbed by the instrumented vehicle. The ionosonde can be used both for long term global observations of the ambient topside ionospheric behavior, and for specific diagnostic support to active space plasma physics experiments. In addition, global surveillance coverage of the ionosphere is within the scope of such a spaceborne ionosonde/HF radar.

III. Benefits

A space-based digital HF ionosonde would provide a multi-purpose, global-coverage diagnostic for research studies of the topside ionosphere. Potential contributions to the investigation of (1) solar-terrestrial relationships, (2) ionosphere-magnetosphere coupling dynamics, and (3) space communications are available. In addition, such a facility would allow dramatic advances in the HF radio astronomy field, heretofore "blinded" by the earth's ionospheric shield.

IV. Justification

A large number of ionospheric and space plasma physics experiments could be supported by a space-based digital HF ionosonde. Such an ionosonde requires long-duration space deployments, large antennas and power sources. Although not expected to need constant human attention, for optimum flexibility some level of man-machine interfacing would be required.

V. Mission Requirements and Capabilities

- (a) Orbital Parameters -- Both low inclination and near polar orbits are desirable. Orbital altitudes of 400-500 km are preferred.
- (b) Mass, Volume -- TBD, but a large (at least tens of meters) antenna array can be anticipated.
- (c) Power -- The power requirements depend on a number of inter-related TBD parameters, including antenna size, capacitor bank and heat dissipation limitations, and desired radar transmitter pulsing characteristics and operational duty cycle.

9 4 75 Es

Code: GDCD 0243

PAYLOAD ELEMENT SYNTHESIS

- (d) Thermal Control -- TBD, but heat dissipation requirements can be anticipated to be small.
- (e) Attitude, Stabilization -- An earth-looking attitude is required. Pointing characteristics may in part be determined by the antenna size and spacings.
- (f) Viewing -- An earth-viewing capability is required. For potential radio astronomy applications this may need to be extended to include full sky coverage, using backlobes of the receiving antennas.
- (g) Environmental Constraints -- TBD, possible RF noise background constraints.
- (h, i) Data Management, Communications, Crew Timeline -- For general atmospheric monitoring purposes, unmanned operation may be acceptable. However, for specific experimental observations, manned operation may be necessary for real-time data management.
- (j) Operations Schedule, Maintenance, Lifetime -- TBD.

VI. Space Station vs. Free Flyer

Antenna size requirements, as well as possible frequent man-machine interfacing needs, determine this radar to be necessarily a space station mission.

* ** ** ** * * * * * **

1		
PAYLOAD ELEMENT NAME Solar Terret Observatory/Advanced	CODE 6 D C D D 2 4 4	
CONTACT W Hardy/! Peterson M7 21-0530		Science & Applications
		(non-commercial)
San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Technology
STATUS		
Operational Planned Approved	nod Idato	U) Operations
	Opportunity	Type Number 3
First flight, yr 2000 No. of flights 1 Duration of Flight, days 2190 OBJECTIVE		(see Table A) Importance of the Space Station to this Element
Simultaneously investigate solar variability, wave-particle processes, magnetosphere-ionosphere mass transport, global electric circuit, upper atmospheric dynamics, middle atmosphere chemistry and energetics, lower atmospheric turbidity, and planetary atmospheric waves.	, wave-particle nsporu, global elec- ddle atmosphere turbidity, and	1 - low value but could use 10 - vital Scale 1 - 10 8
DESCRIPTION The STO hardware constitutes 17 experiments (a mission itself) grouped onto two single pallets and a two-pallet train. One pallet contains a pointing mount. The chemical release module (CRM) and recoverable plasma diagnostic package will be deployed from the space station. The instruments are: total radiation monitor, UV radiance monitor, soft X-ray telescope, white light and line cronographs, IR spectrometers, X-ray telescope (AXET), UV and visible spectrometer, upper atmospheric temp sounder, upper atmospheric wind sensor, wave injection (WISP), chemical release module, and recoverable plasma diagnostic package.	17 experiments (a missipallet contains a point diagnostic package with monitor, UV radiant spectrometers, X-ray under, upper atmospheroverable plasma diagnatical diagnatics.	O hardware constitutes 17 experiments (a mission itself) grouped onto two two-pallet train. One pallet contains a pointing mount. The chemical and recoverable plasma diagnostic package will be deployed from the space ents are: total radiation monitor, UV radiance monitor, soft X-ray teledeled line cronographs, IR spectrometers, X-ray telescope (AXET), UV and visper atmospheric temp sounder, upper atmospheric wind sensor, wave injectelease module, and recoverable plasma diagnostic package.

CODE 6 D C D 0 2 4 4 Page 2 of 3	_
100	•
POINTING/ORIENTATION Use direction Inertial Solar Earth Truth Sites (if known) Pointing accuracy, arc sec 1800 Field of view, deg 360 Sperical Pointing Stability (Jitter) arc sec/sec Special Restrictions (Avoidance)	
JAC Para Para U	
ATIONS quirements! X Realtime Of \times Obseryption Requis Command Rate (Ki)ata Processing Req	
Data Types: Analog XDigital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 42.000 Downlink Frequency (MHZ)	

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Spassive (Fluid Loop) max non-operational min 6500 max 15,850 max 10,	CODE 6.0.0.0.2.4.4	4 Page 3 of
EQUIPMENT PHYSICAL CHARACTERISTICS Location: Internal Etternal Operassurized L,m 13 U,m 300 H,m 10 Consumables Types Consum	X Passive (Fluid Loop) C operational min non-operational min operational min non-operational min	
CREW REQUIREMENTS Crew Size Skills (See Table B) EUFL Skills (See Table B) EUFL Skill Skill Anson Service, Reconfig. SERVICING/MAINTENANCE SERVICE Interval, day Returnables, kg Man/Hrs Req. Dolivorables, kg Man/Hrs Req. Dolivorables, kg Man/Hrs Req. Annoth: Special targets include: Earth's atmosphere and limb, magnetic field lines, auroral zones, Sun, stars, and cold sky. Desired to attain latitude extremes (magnetic) between 2200 and 2400 local time. STO emits particle beam (electron, He, Ar) RF radiation (1-kHz,0.1-30 MHz, ~140 Mhz, and ~400 MHz), laser light (IR-UV), and purge gases (Xe, CH4, and CO2).	PHYSICAL CHARACTERISTICS Internal External Remote Internal Pressurized Unpressurized L,m 13 U,m 300 H,m 10 Launch mass, kg Consumables Types Acceleration sensitivity, a min	
EUA X VES ILL 3 3 3 ELVEL 3 3 3 Hrs/Day 0.67 0.67 EUA X VES INO Reason Service, Reconfig. Hrs/EUA 20 SERVICING/MAINTENANCE 365 CONFIGURATION CHANGES:Interval, day Ban/Hrs Req. A Ban/Hrs Req. A Beturnables, kg A 2500 CONFIGURATION CHANGES:Interval, day Boliverables, kg A 2500 CONFIGURATION CHANGES:Interval, day Beturnables, kg A 2500 Boliverables, kg A 2500 Returnables, kg A 2500	REQUIREMENTS Size Task Assignment.	Inst/Analyze Data
EUA XVES ☐NO Rouson Service, Reconfig. Hrs/EUA 20 SERUICING/MAINTENANCE SERUICING/MAINTENANCE SERUICING/MAINTENANCE SERUICING/MAINTENANCE SERUICING/MAINTENANCE 365	ts (See Table B) SKILL 4	
SERVICEIINterval, days SERVICEIInterval, days SONFIGURATION CHANGESIInterval, day SPECIAL CONSIDERATIONS/See Instructions The operating power can vary between 10 and 21 km over an orbit. Special targets include: Earth's atmosphere and limb, magnetic field lines, auroral zones, Sun, stars, and cold sky. Desired to attain latitude extremes (magnetic) between 2200 and 2400 local time. STO emits particle beam (electron, He, Ar) RF radiation (1-kHz,0.1-30 MHz, ~140 Mhz, and ~400 MHz), laser light (IR-UV), and purge gases (Xe, CH4, and CO2).	0.67	
SERUICING/MAINTENANCE SERUICE: Interval, days Returnables, kg Returnables, kg SONFIGURATION CHANGES: Interval, day SPECIAL CONSIDERATIONS/See Instructions The operating power can vary between 10 and 21 kw over an orbit. Special targets include: Earth's atmosphere and limb, magnetic field lines, auroral zones, Sun, stars, and cold sky. Desired to attain latitude extremes (magnetic) between 2200 and 2400 local time. STO emits particle beam (electron, He, Ar) RF radiation (1-kHz,0.1-30 MHz, ~140 Mhz, and ~400 MHz), laser light (IR-UV), and purge gases (Xe, CH4, and CO ₂).	X YES No Rouson Service, Reconfig.	20
SONFIGURATION CHANGES: Interval, day 365 Man/Hrs Req. 4 Dollverables, kg Returnables, kg Returnables, kg SPECIAL CONSIDERATIONS/See Instructions The operating power can vary between 10 and 21 Kw over an orbit. Special targets include: Earth's atmosphere and limb, magnetic field lines, auroral zones, Sun, stars, and cold sky. Desired to attain latitude extremes (magnetic) between 2200 and 2400 local time. STO emits particle beam (electron, He, Ar) RF radiation (1-kHz,0.1-30 MHz, and ~400 MHz), laser light (IR-UV), and purge gases (Xe, CH4, and CO ₂).	Consumples, kg	
SPECIAL CONSIDERATIONS/See Instructions The operating power can vary between 10 and 21 Kw over an orbit. Special targets include: Earth's atmosphere and limb, magnetic field lines, auroral zones, Sun, stars, and cold sky. Desired to attain latitude extremes (magnetic) between 2200 and 2400 local time. STO emits particle beam (electron, He, Ar) RF radiation (1-kHz,0.1-30 MHz, ~140 Mhz, and ~400 MHz), laser light (IR-UV), and purge gases (Xe, CH4, and CO ₂).	day 365	1
	SPECIAL CONSIDERATIONS/See Instructions The operating power can vary Kw over an orbit. Special targets include: Earth's atmosphere and limb, magnet auroral zones, Sun, stars, and cold sky. Desired to attain latitude extremes (2200 and 2400 local time. STO emits particle beam (electron, He, Ar) RF radiat MHz, ~140 Mhz, and ~400 MHz), laser light (IR-UV), and purge gases (Xe, CH4, an	between 10 and 21 ic field lines, magnetic) between ion (1-kHz,0.1-30 d CO ₂).

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

CDCD CODE 0244	ELEMENT NAME SOL	AR TERR. OBS - ADVANC	ED
ACCOMODATION: X A	TTACHED FREE FL	YER OTV OPS	
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATT	TACHMENT AND CHECKOUT)	
DATE(S) 2000	INT. HRS EVA	A HRS EVA CREW	
		•	
☐ NOT APPLICABLE			
2. SERVICE (E.G., REPLENI	SH/RESUFFLY)		
	S L INVICES 5	- · · ·	
TMS/OTV REQUIRE	<u> </u>	STATION HRS PER SERVICE	2
☐ NOT APPLICABLE		EVA HRS PER SERVICE	
		EVA CREW SIZE	1
3. STATION OPERATIONAL	SUPPORT (AVG. TIME FOR	MONITOR, INSPECT, ETC.)	
1-1/3 HRS PER DAY	(INTERNAL)		
HRS PER DAY	(EVA)	•	
☐ NOT APPLICABLE	•		
4. RECONFIGURATION			
	S TOTAL RECONFIGS.	. 5	
TMS/OTV REQUIRE		STATION HRS PER RECONFIG	. 2
☐ NOT APPLICABLE		EVA HRS PER RECONFIG.	
		EVA CREW SIZE	
5. DEACTIVATION/REMOV	_		
UATE(S)1	NT. HRS EVA	HRS EVA CREW _	
■ NOT APPLICABLE		-	
6. NOTES (BRIEFLY DESCR	IBE TASKS IN 1 THROUGH	5 ABOVE)	
4. Sensor/detecto	ng equipment rs each 2 days/wee r reconfiguration ion continues past	assumed	

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Code: GDCD 0244

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Solar Terrestial Observatory - Advanced

Reference Documents:

1. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

This payload element is based upon the STO description originally developed for the MSFC SASP. The mission description and physical characteristics were taken directly from Ref 1, p D-57.

For this late time frame, a manned platform in high inclination (57-90 degrees) orbit is required.

A mission duration of at least six years (one-half of a solar activity cycle) is assumed.

Manned interaction with both natural and artifically-induced phenomena is required. Servicing, updating, resupply and reconfiguration also require manned support. This payload element would be operated intermittantly; i.e., two days per week. A crew of two will be required during operation to monitor, control and coordinate the use of the equipment.

Launch date and mission duration was derived.

Page 2 of 7 Volume II, Book 1 Appendix I

Code: GDCD 0244

PAYLOAD ELEMENT SYNTHESIS

SOLAR TERRESTRIAL OBSERVATORY: (STO)

DESCRIPTION

STO contains hardware for 17 flight experiments and constitutes a mission in itself. The instruments are grouped onto two single pallets and a two-pallet train. One of the pallets contains a pointing mount. The Chemical Release module (CRM), a free-flyer, will be launched separately.

OBJECTIVE

The STO science objectives lie in the following areas: Solar Variability, Wave-Particle Processes, Magnetosphere-Ionsphere Mass Transport, Global Electric Circuit, Upper Atmospheric Dynamics, Middle Atmosphere Chemistry and Energetics, lower Atmospheric Turbidity, and Planetary Atmospheric Waves. Investigations in the above-listed areas require extensive simultaneous operation of the STO instruments.

Instruments assigned to each of the four pallets are listed in Table 0244.

SPECIAL CONSIDERATIONS/CLARIFICATIONS

EMMISSIONS/SUSCEPTIBILITIES

Since STO occupies the whole Space Platform, emissions and susceptibilities are an internal matter. In general STO instruments are sensitive to H₂O, CO₂, and optical contaminants effective in the IR-visible-UV spectral regions. STO emits particle beams (electrons, He, and Ar) rf radiation (1-30 kHz 0.1 MHz, -140 MHz, and -400 MHz), laser light (IR-UV), and purge gases (Xe, CH, and CO₂).

VIEWING REQUIREMENTS

STO instruments have a variety of viewing requirements to include solar, limb, limb through solar occultation, nadir, and magnetic field pointing. Desire attainment of latitude extremes (magnetic) between 2200 and 2400 local time.

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Code: GDCD 0244

PAYLOAD ELEMENT SYNTHESIS

Table 0244 Solar Terrestrial Observatory (STO) Instruments

ACR	ONYM	NAME	FUNCTION
1.	ACR	Active Cavity Radiometer	Total irradia <i>n</i> ce monitor
2. S	USIM	Solar Ultraviolet Spectral Irradiance Monitor	UV irradiance monitor
3.	SX	Soft X-Ray Telescope	
4.	Lyman Alpha	White Light Coronagraph	
5.	ATMOS-P	Atomspheric Time Molecules Observed by Spectroscopy	<pre>IR Spectrometers Absorption/Emission</pre>
6.	ERBE	Earth Radiation Budget Experiment	Radiation Balance Monitor
7.	SEPAC	Space Experiments with Particle Accelerators	Particle Injector
8.	MMP	Magnetospheric Multiprobes	F.F. Plasma Measurement Installation
9.	LIDAR	Light Detection and Ranging Facility	
10.	AEP I	Atmospheric Emission Photometric Imaging	Low Light Level TV
11.	MX	Atmospheric X-Ray Telescope (AXET)	Aural Monitor
12.	ISO	Imaging Spectrometric Observatory	UV and Visible Spectrometer
13.	ALS	Advanced Limb Scanner	Upper Atmospheric Temperature Sounder
14.	HRDI	High Resolution Doppler Imager	Upper Atmospheric Wind Sensor
15.	WISP	Waves In Space Plasmas	
16.	CRM	Chemical Release Module	
17.	RPDP	Recoverable Plasma Diagnostic Package	Subsatellite

GDC-ASP-83-002

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Code: GDCD 0244

PAYLOAD ELEMENT SYNTHESIS

1804 45		INSTANCE	ACROHER	15 (54)	PARTEL PARTY	POMER (W)	CONTROL	DATA (Naps.)	97.W.158	POLITIES ACCEN.
	-7	TOTAL INRADIANCE NONITON	ACB.	22	•	10/13	Cold plate	0.217/MA	į	7
	~	W IRABIANCE MONITOR	SUSTR	2	9\$	(31/62)	Passive	8.531/MA	į	12
•	-	SOFT X-MAY TELESCOPE	15	*	æ	901/02	Pessive	TB6/3.8 • 480	į	Są.
+	•	MITE LIGHT CONCHASANN RESOURCE LINE CONCHASANN	Table 1	2	92	982/19	Passing	TB&/13.5	į	3
	•	In Assortion SPECTRONETER In Douision SPECTRONETER	A THOS - P	ş	2	316/376	Cold Plate	16.788	Semant/rise	a 11.00
	•	MANIATION GALANCE HONITON) E	z .	•	82/88	Passine	1.128/MA	j	4 1 2
>	~	PARTICLE IALECTOR	SEPAC	63)	×	990K/900H	Cold plates	1.4/512 + TV + MS An.	migh Mass. Lot., Bight	# 1.0# # 1.0#
-	•	MALTIPHOMES	1	1692	9 5>	10/103	Passive	99/901	j	ŀ
	•	11000	T I I I I	8	81	9899/8055	Cold plates	(52/104	lateratt.	\$2 A
	2	LOW LIGHT LEVEL TELEVISION	1434	174	8	348/566	Cald Plats	1.0/277 • TV	SCORC/MESS	TSME
	=	A-BAY TELESCOPE (ALET)	ZN	519	95	196/294	Passing	81-/ 981	į	3
>	•	AMBIATION BALANCE NOBITOR	3913	88	•	99/25	Passina	1.126/M	į	# 1[2
<	21	UV AND VISIBLE SPECTACAETER	93.	\$12	¢15	196/216	Cald Plate	0.001/125 or 2000	by/Wight	3 7 1 3
•	2	UPPER ATMOSPHERIC TEMPERATURE SOUNDER	AŁS	n	410	165/190	Cold Pinte	The/T	j.	3
	2	UPPER ATHOSPHERIC NIMB SEKSOR	JOHN	×	4,0	82/150	Passiva	TD#/4	à	9 1114
	15	415	\$15	775	8,	1906/7908	Cald plates	106/7000	Bay/Ringled	÷2 4
FREEFLYENS	2	CHENICAL MELENSE HODINE	15 5	1988	8		-915 an	IN STO-ATTACKED INNERVAL		
LAMON	2	BECOVERABLE PLASON BLAGNOSTIC PACKAGE	ŧ	\$	ŧ	95/95	Cold plate	0.296/32 • 1280	E	i

Summary of Characteristics and Requirements for STD Instruments

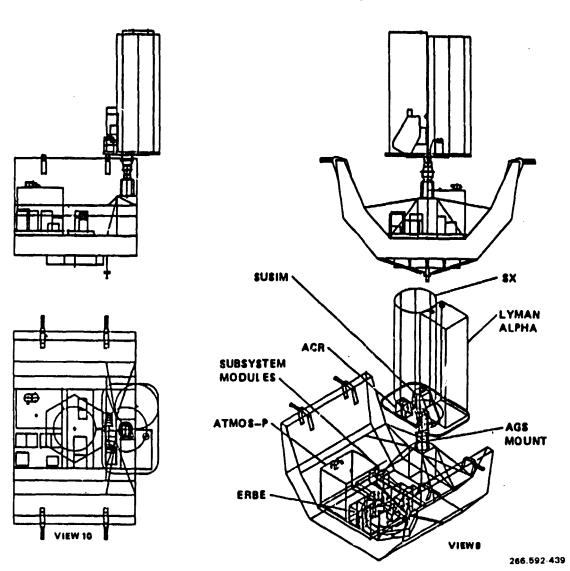
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PAYLOAD ELEMENT SYNTHESIS



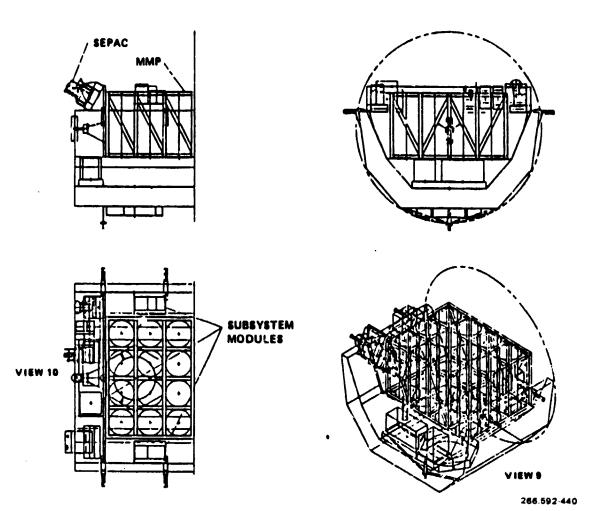
+Y Axis Pallet

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PAYLOAD ELEMENT SYNTHESIS



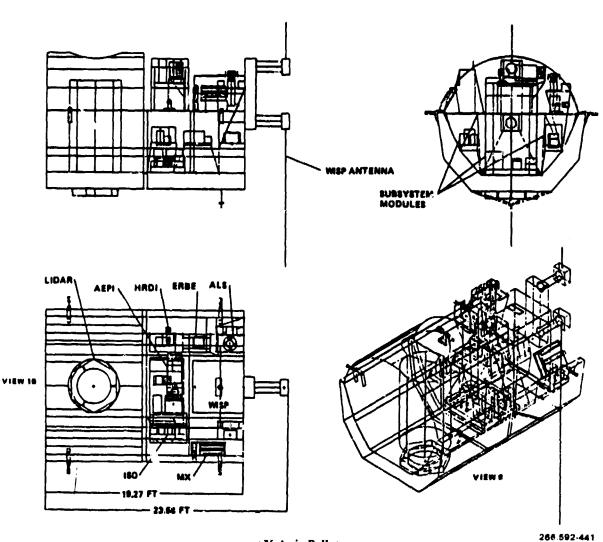
-Y Axis Pallet

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Page 7 of 7 Volume II, Book 1 A; pendix I

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+X Axis Pallet

- 1		Page 1 of
Space Plasma Physics Pl/Advanced	CODE G D C D O 2 4 5	•
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division Addrass P.O. Box 85357		Applications (non-commercial)
Sa. Diego, CA 92138		Commercia!
Telephone (619) 277-8900, Ext. 3778/2130		Technology
Operational Clanned		Operations
	ia Ity	Tune Number
First flight, yr 1998 No. of flights 1 Duration of Flight, days 730		(see Table A) Importance of the
& <u>5</u>	zing observa-	· ·
		Scale 1 - 19 8
The SPP payload contains the following instruments: wave injection (WISP), solar monitors (ACM, SUSIM, X-ray), low light TV (AEPI), X-ray telescope (AXET), UV and visible (ISO). Subsatellite (PPDP) and multiprobes (MP) are included. The integration hardware includes an active thermal control loop, a shelf and a special structure for mounting the WISP dipole antenna. The SPP is packaged on a spacelab pallet.	s: wave injectior pe (AXET), UV and tegration hardwar mounting the WIS	(WISP), solar monitors (ACM, i visible (ISO). Subsatellite e includes an active thermal? P dipole antenna. The SPP

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CODE 6 D C D 0 2 4 5 Page 2 of 3	6
OPBIT CHARACTERISTICS Apogee, km 400 Tolerance + 100 150 Inclination, deg 57 Noda: Angle, deg Eptemeris Accuracy, m Eptemeris Accuracy, m	
ORIENTATION Sction Section Serth	
accuracy, are secrigid of View, degStability (Jitter)are sec/secRetrictions (Avoidance)	
Power, W Duration, hrs/day	
Frequency,	
UNICATIONS grequirements! \(\times\) Realting \(\times\) Of ption/Decryption Require Req.! Command Rate (K) and Data Processing Req iption	
Data Typos: Analog NDigital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Pqr. Orbit) Recording Rate (KBPS)	

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CODE G_D_C_D_O_2_4_5_	2.4.5. Page 3 of 3
THERMAL Gottive Passive Temperature, deg C operational min non-operational min Heat Rejection, w operational min non-operational min max	
EQUIPMENT PHYSICAL CHARACTERISTICS Location: Internal External Temote Equipment ID/Function Pressurized 4.5 L,m 5 U,m 300 H,m 10 Launch mass, kg Consumables Types	Stowed
Task Assignment	t c
ls (See Table B) SKILL LEUEL	
EUA TYES X NO Reason Hrs/FUA	
g Consumables, Interval, day	1 1 1
SPECIAL CONSIDERATIONS/Sam Instructions	les, kg
ired for wave o devotes one (interleaved	injection (WISP) and particle week/month of intensive operation pulses) is a SEFAC/WISP opera-

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 0245	ELEMENT NAME _	SPACE PL	ASMA PHYS	CS P/L- ADVANC	CED
ACCOMODATION: X ATTA	CHED	FLYER (OTV OPS		
1. STATION ACTIVATION (E.G.,	SET-UP/ASSEMBLY/	ATTACHMEN	T AND CHECK	0UT)	
DATE(S) 1998 INT.	HRS 1	VA HRS	EV	A CREW	_
		_		<u> </u>	_
☐ NOT APPLICABLE					
2. SERVICE (E.G., REPLENISH/R	ESUPPLY)				
INTERVAL 180 DAYS	TOTAL SERVICES	3			
TMS/OTV REQUIRED _		STATI	ON HRS PER S	ERVICE 16	_
□ NOT APPLICABLE _		EVA H	RS PER SERV	ICE	_
		EVA (REW SIZE		_
3. STATION OPERATIONAL SUP	PORT (AVG. TIME F	OR MONITOR	I, INSPECT, ET	C.)	
0.5 HRS PER DAY (IN	TERNAL)				
HRS FER DAY (EV	A)				
☐ NOT APPLICABLE			-		
4. RECONFIGURATION					
INTERVAL DAYS	TOTAL RECONFI	GS			
TMS/OTV REQUIRED		STATIO	ON HRS PER R	ECONFIG.	-
▼ NOT APPLICABLE		EVA H	RS PER RECON	IFIG.	-
		EVA C	REW SIZE		-
5. DEACTIVATION/REMOVAL					
DATE(S) 2000 INT.	IRS E	VA HRS	EVA	CREW	_
NOT APPLICABLE					~
6. NOTES (BRIEFLY DESCRIBE)	FASKS IN 1 THROUG	H 5 ABOVE)			
 Station OPS Monitor Assume Station OP 	s				

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 0245

PAYLOAD ELEMENT SYNTHESIS

Payload Element Names: Space Plasma Physics Payload - Advanced

Reference Documents:

1. Space Platform Payload Data, Science and Application Space Platform payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

This payload element is based upon the Space Plasma Physics (SPD) descriptions originally developed for the MSFC SASP. The mission description and physical characteristics were taken directly from Ref 1, p D-14.

For this late time frame, a manned platform in high inclination orbit is required.

After two years of on-orbit development and operations, the instruments of this payload element become part of the STO (GDCO-0244).

Launch date and mission duration were derived.

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Code: GDCD 0245

PAYLOAD ELEMENT SYNTHESIS

Space Plasma Physics - SPP

DESCRIPTION

The SPP payloads contains the SEPAC, WISP, and AEPI instruments. The integration hardware includes an active thermal control loop, a shelf on which to mount the SEPAC electron gun, MPD arcjet, and instruments, and a special structure for mounting the WISP dipole antenna. The SPP payload is packaged on a Spacelab pallet.

INSTRUMENTS

SEPAC = Space Experiments with Particle Accelerators.

WISP = Waves in Space Plasmas.

AEPI = Atmospheric Emission Photometric Imaging.

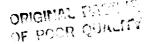
OPERATIONAL CONSIDERATIONS

As a baseline scenario devote 1 week/month of intensive operation to SEPAC and WISP. Assuming WISP is in a passive mode while SEPAC is operating and vice versa. Provide additional operation where resources permit. Coordinated transmissions (interleaved pulses) is a SEPAC/WISP operational objective and capability to support such operation should be assessed. AEPI is included in the payload only to support SEPAC and WISP FOs. AEPI is desired for all SEPAC operations and some WISP operations. AEPI is typically pointed along the magnetic field line to look for an auroral spot.

SPECIAL CONSIDERATIONS/CLARIFICATIONS

EMISSIONS/SUSCEPTIBILITIES:

SEPAC emits an electronic beam (1-20 keV energy, 1-25 kW power), a He or Ar Magneto-plasma-dynamic arcjet (2-10 kJ pulse, 250 eV particle energy), and a neutral gas plume. WISP transmits high power plasma/radio waves in two broadcast bands, VLF (1-30 kHz) and HF (0.1-30 mHz). AEPI is sensitive to standard optical contaminants.



GDC-ASP-83-002

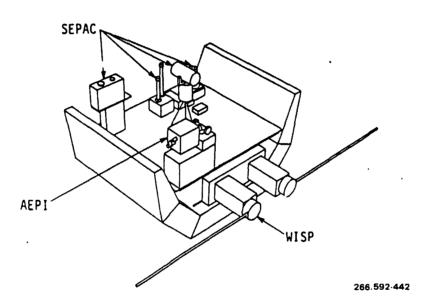
Page 3 of 3 Volume II, Book 1 Appendix I

Code: GDCD 0245

PAYLCAD ELEMENT SYNTHESIS

VIEWING REQUIREMENTS:

A 45 degree (half angle) avoidance cone is required for the SEPAC particle beams. The electron beam has a divergence angle of -5 degrees and is steerable with a 30 degree (half angle) cone. The WISP dipole antenna must have a clear view to space. Most SEPAC and WISP functional objectives (FOs) require pointing with respect to the geomagnetic field vector. AEPI would point along magnetic field lines to support SEPAC and AEPI FOs.



Space Plasma Physics Group

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PAYLOAD ELEMENT NAME CODE	TYPE
Solar Terrestrial Observatory	X Seiones L
ACT	Applications
Address p n Roy 86367	
	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Technology Development
STATUS	
Operational OPlanned	[]Operations
☐Approved ⊠Candidate ☐Opportunity	Type Number
First flight, yr 1994 No. of flights 1 365 Duration of Flight, days 365	(see Table A) Importance of the Space Station to
	this Element
Simultaneously investigate solar variability, wave particle processors, magnetosphere-ionosphere mass transport, global electric circuit, upper atmospheric dynamics, middle atmosphere chemistry and energetics, lower atmospheric turbidity, and	1 - low value but could use 10 - vital
waves.	Scala 1 - 10 5
EESCRIPTION The STO hardware constitutes 17 experiments (a mission itself) grouped onto two single pallets and a two-pallet train. One pallet contains a pointing mount. The chemical release module (CRM) and recoverable plasma diagnostic package will be deployed from the Space Staion. The instruments are: total radiation monitor, UV radiance monitor, soft X-ray telescope, white light and line cronographs, IR spectrometers, radiation balance monitor (2), particle injector, multiprobes, LIDAR, LLL Television, X-ray telescope (AXET), UV and visible spectrometer, upper atmosphere; C temp sounder, upper atmospheric wind sensor, wave injection (WISP), chemical release module, and recoverable plasma diagnostic package.	ssion itself) grouped onto two nting mount. The chemical 11 be deployed from the Space e monitor, soft X-ray tele- ion balance monitor (2), par- pe (AXET), UV and visible wind sensor, wave injection c package.

CODE 6.0 C.0.0.2.4.6, Page 2 of 3
INTA If Irac
ic erating andby ak
DATA/COMMUNICATIONS Monitoring requirements! Monitoring requirements! Monitoring required Monitoring Required Uplink Req.: Command Rate (KBS) Description
Data Types: Analog XDigital Hrs/Day Film (Amount) Live TU (Hrs/Day) Cloe TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Excording Rate (KBPS) 42.000 Downlink Frequency (MHZ)

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C			 -	, , , ,		,		
G.D.C. D. O. 2, 4.6 Page 3 of 3	X Passive (Fluid Loop) C operational min 6500 max 15,850 non-operational min 6500 max	PHYSICAL CHARACTERISTICS [] Internal [X] External [] Remote [] Internal [] Pressurized [] Unpressurized [] H,m [] A.5 Stowed [] U,m [] J0. H,m [] Deployed [] L,m [] U,m [] J0. H,m [] Deployed [] Launch mass, kg [] Consumables Types [] Acceleration sensitivity of min [] max	2 Task Assignment Operate/Poi	e B) SKILL LEVEL Hrs/De	No Reason 8	kg Consumables, Interval, day Man Hours Deliverables, kg		The operating power can vary between 10 and 21 Kw over an orbit. Special targets include: Earth's atmosphere and limb, magnetic field lines, Auroral zones, sun, stars and cold sky. Desired to attain latitude extremes (magnetic) between 2200 and 2400 local time. Instruments sensitive to: H20, CO ₂ and IR-visible - UY spectral region contamination. STO emits particle beam (electrons, He, AR) RF radiaiton (1-KHz, 0.1 -30 MHz, ~140 MHz, and ~400 MHz,, laser light (IR-UV), and burge gases (Xe, CH4 and CO ₂).
	•	EQUIPMENT PHYSICAL Location: Dinter Equipment ID/Functi	CREW REQUIREMENTS Crew Size	ls (See Table	EUA XIYES	SERVICING/MAINTENANCE SERVICE: Interval, day Returnables, CONFIGURATION CHANGES	SPECIAL CONSIDERATI	The operating power can Earth's atmosphere and Desired to attain latitu sensitive to: H ₂ O, CO ₂ beam (electrons, He, AR (IR-UV), and purge qase

GDC-ASP-83-002 PAYLCAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book i Appendix I

GDCD CODE 0246 ELEMENT NAME SOLA	? TERRESTRIAL OBSERV.	ATORY
ACCOMODATION: X ATTACHED TFREE FLYE	R* OTV OPS	
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	CHMENT AND CHECKOUT)	
DATE(S) 1994 INT. HRS EVA H	IRSEVA CREW	
-		
☐ NOT APPLICABLE		
2. SERVICE (E.G., REPLENISH/RESUPPLY)		
INTERVAL 180 DAYS TOTAL SERVICES	<u></u>	
TMS/OTV REQUIRED	STATION HRS PER SERVICE	8
□ NOT APPLICABLE	EVA HRS PER SERVICE	8
	EVA CREW SIZE	
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR M	ONITOR INSPECT FTC)	
2 HRS PER DAY (INTERNAL)		
HRS PER DAY (EVA)		
□ NOT APPLICABLE		
_		
4. RECONFIGURATION		
INTERVAL DAYS TOTAL RECONFIGS.		
TMS/OTV REQUIRED	STATION HRS PER RECONFIG	i
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.	
	EVA CREW SIZE	
5. DEACTIVATION/REMOVAL		
DATE(S) 1995 INT. HRS EVA H	RS EVA CREW _	
	-	
☐ NOT APPLICABLE		
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 A * Free flyer accommodation is an altern require re-evaluation of all requirem	ate mode, and if use	ed will
1. and 5. above - assume station operati	ons	
 Service on probe/satellite consumab Operate/point instruments and analy 	les	

Page 1 of 7 Volume II, Book 1 Appendix I

Code: GDCD 0246

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Solar Terrestrial Observatory - (STO)

Reference Documents:

1. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

This payload element is the same as the STO description originally developed for the MSFC unmanned SASP. The mission description and physical characteristics were taken directly from Ref 1, p D-57.

For this early time frame, a manned accommodation is preferred although an unmanned platform in high inclination orbit (57 degrees) is acceptable.

Launch date and mission duration were derived.

Page 2 of 7 Volume II, Book 1 Appendix I

Code: GDCD 0246

PAYLOAD ELEMENT SYNTHESIS

Solar Terrestrial Observatory (STO)

DESCRIPTION

STO contains hardware for 17 flight experiments and constitues a mission in itself. The instruments are grouped onto two single pallets and a two-pallet train. One of the pallets contains a pointing mount. The Chemical Release Module (CRM), a free-flyer, will be launched separately.

OBJECTIVE

The STO science objectives lie in the following areas: Solar Variability, Wave-Particle Processes, Magnetosphere-Ionsphere Mass Transport, Global Electric Circuit, Upper Atmospheric Dynamics, Middle ATmosphere Chemistry and Energetics, lower Atmospheric Turbidity, and Planetary Atmospheric Waves. Investigations in the above-listed areas require extensive simultaneous operation of the STO instruments.

Instruments assigned to each of the four pallets are listed in Table 0246.

SPECIAL CONSIDERATIONS/CLARIFICATIONS

EMISSIONS/SUSCEPTIBILITIES

Since STO occupies the whole Space Platform, emissions and susceptibilities are an internal matter. In general STC instruments are sensitive to H_2O , CO_2 , and optical contaminants effective in the IR-visible-UV spectral regions. STO emits particle beams (electrons, He, and Ar) rf radiation)1-30 kHz O_1 .-30 MHz, -140 MHz, and -400 MHz), laser light (IR-UV), and purge gases (Xe, CH, and CO_2).

VIEWING REQUIREMENTS

STO instruments have a variety of viewing requirements to include solar, limb, limb through solar occultation, nadir, and magnetic field pointing. Desire attainment of latitude extremes (magnetic) between 2200 and 2400 local time.

Page 3 of 7 Volume II, Book 1 Appendix I

Coue: GDCD 0246

PAYLOAD ELEMENT SYNTHESIS

Table 0246 Solar Terrestrial Observatory (STO) Instruments

ACI	RONYM	NAME	FUNCTION
1.	ACR	Active Cavity Radiometer	Total irradiance monitor
2. :	SUSIM	Solar Ultraviolet Spectral Irradiance Monitor	UV irradiance monitor
3.	SX	Soft X-Ray Telescope	
4.	Lyman Alpha	White Light Coronagraph	
5.	ATMOS-P	Atomspheric Time Molecules Observed by Spectroscopy	IR Spectrometers Absorption/Emission
6.	ERBE	Earth Radiation Budget Experiment	Radiation Balance Monitor
7.	SEPAC	Space Experiments with Particle Accelerators	Particle Injector
8.	MMP	Magnetospheric Multiprobes	F.F. Plasma Measurement Installation
9.	LIDAR	Light Detection and Ranging Facility	
10.	AEPI	Atmospheric Emission Photometric Imaging	Low Light Level TV
11.	MX	Atmospheric X-Ray Telescope (AXET)	Aural Monitor
12.	ISO	Imaging Spectrometric Observatory	UV and Visible Spectrometer
13.	ALS	Advanced Limb Scanner	Upper Atmospheric Temperature Sounder
14.	HRDI	High Resolution Doppler Imager	Upper Atmospheric Wind Sensor
15.	WISP	Waves In Space Plasmas	
16.	CRM	Chemical Release Module	
17.	RPDP	Recoverable Plasma Diagnostic Cackage	Subsateilite

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Code: GDCD 0246

PAYLOAD ELEMENT SYNTHESIS

San Av. San Av. San Av. San Av. San Av. San Av. San Av. San Av. San Av. San Av. San Av. San Av. Cont.	1804 92		INSTRUMENT	ACRORTH	(64) (63)	A PALLET	POMER (W) OP./PEAK	THEMAL	DATA (18ps.)	OPERATION	MOINTING ACCON.
1		-	TOTAL IRRADIANCE HONITOR	ACA	02	•	16/13	Cold plate	0.217/NA	E &	3 2
SOFT S.ANT TRESCOPT		~	UV IRRADIANCE NONITOR	SUSIN	3	01 >	£81/621	Passive	D. 531/IIA	ĭ	Fine
High commutation Arrival Arriv	•	~]	SOFT M-RAY TELESCOPE	15	191	92	301/06	Passive	180/3.8 + 408	£ 3.	3
1	-	•	WHITE LIGHT CONDRAGAZHH RESONANCE LINE CONDRAGAAN	LYNAM	052	92	93/18	Passive	Tb0/13.6	į	165
AMMINITION EALANGE MONITOR EALANGE MONITOR GENE 557460 Passivo 1.150/UM Cont.		•	IN ABSORPTION SPECTNOMETER IN EMMISSION SPECTNOMETER	ATMOS-P	8	#	310/330	Cold Plate	16.750 15.760	Same 11/7/150	ESS to
MALTIPHODES SEPAC 637 25 1000/3000 Cold places 1.4/512 TW 1611, Nights 1611, Nights 1621,		•	NAUTATION BALANCE NONITON	(M)	35	•	99/29	Patrito	1.120/MA		B 11.5
1 1 1 1 1 1 1 1 1 1	>	~	PARTICLE INJECTOR	SEPAC	(1)	æ	900K/90UI	Cold plates	1.4/512 + TV + 18 An.	High Hass. Let., Hight	# 11 m
1 LOM LIGHT LEVEL TELEVISION AEPI 174 <10 340/4600 Cold Plates TRB/253 Intermit. 10 LOM LIGHT LEVEL TELEVISION AEPI 174 <10 340/4600 Cold Plates 1.0/277 * TY SEPACANISP 11 L-MAY TELESCOPE (ARET) MA 210 <10 196/254 Passive 1.180/MA Cont. C	_	•	MALTIPROBES	1	7691	95	143/143	Passive	09/801	Ç BY.	:
10 COM LIGHT LEVEL TELEVISION AEP! 174 <10 340/540 Cold Plate 1.0/277 + TY SEPACANISP 1.0 CONT.	•	LIDAR	CIBAR	9061	100	3500/4/0050	Cold plates	Te6/253	Internit.	į	
11 A-MAT TELESCOPE (ALET) NA. 210 410 186/294 Passive T88/-19 Cent.		2	LOM LIGHT LEVEL TELEVISION	AEPi	174	01×	340/860	Cold Plate	1.0/277 • TV	SEPAC/MISP	#KST
12 UV AND VISIBLE SPECINOMETER 150 245 416 180/216 Cold Plate 0.001/125 or 2000 Day/Hight 13 UPPER ATHOSPHERIC MAD 15 245 410 166/190 Cold Plate 0.001/125 or 2000 Day/Hight 14 UPPER ATHOSPHERIC MAD 76 410 82/150 Cold Plate TBD/4 Conf. 15 UISP 180/18 ATHOSPHERIC MAD 76 410 42/150 Cold Plates TBD/4 Day/Hight 15 UISP 1900 100 100 1000/7000 Cold Plates TBD/7000 Cold Plat		=	A-BAY TELESCOPE (ARET)	7	210	¢10	196/294	Passive	198/-10	Cent.	First
12 UV AND VISIBLE SPECINDMETER 150 245 415 190/216 Gold Plate 0.001/125 or 2000 Day/Night 13 UPPER ATMOSPHERIC MED 76 410 42/160 Cold Plate TBD/4 Gont. 14 UPPER ATMOSPHERIC MED 76 410 42/160 Cold Plates TBD/4 Goy 15 USP 15 USP 732 450 1000/7000 Gold Plates TBD/7000 Goy/Night 15 USP MISP 732 440 440 440 440 50/50 Gold Plate 0.286/32 * 1200 Gont. 15 USP MISP MIS	×	•	RADIATION BALANCE NONITOR	1991	\$\$	•	82/60	Passiva	1.120/MA	.	P 11 4
13 UPPER ATMOSPMERIC ALS 72 <10 166/190 Cold Plate TRD/8 Cont. 14 UPPER ATMOSPMERIC MEDI 76 <10 82/150 Passive TRD/4 Cont. 15 UISP 732 <50 1000/7000 Cold Plates TRD/7000 Cont. 15 CHCMICAL RELEASE MODAE CIM 1900 100	<	2		3	345	دا\$	190/218	Cold Plate	0.001/125 or 2000	Day/Hight	F. 11.
14 LIPER AINDSPHERIC HRD1 76 410 82/160 Passive 180/4 Copy 15 MISP 732 450 1000/7000 Cold pistes 786/7000 Cold pistes 786/7000 Cold pistes 786/7000 Cold pistes 80/100 Cold pistes 786/7000 Cold pistes 786/7000 Cold pistes 786/700 Cold pistes 786/700 Cold pistes 786/700 Cold pistes 786/70 Cold pistes 786/70 Cold pistes		2	UPPER ATHOSPHERIC TEMPERATURE SOUNDER	ALS	2.5	6 0	165/190	Cold Plate	18D/8	- <u>;</u>	1881 1881
15 UISP LIEMICAL RELEASE MODULE COM 1900 100 100 Lold plates TRA/7000 100 100 MD SID-ATIACHED MANDLAGE 17 RECOVERABLE PLASSIA APPR 440 '40 50/50 Cold plate 0.286/32 + 1200 0		=	UPPER ATHOSPHERIC WIND SENSOR	10991	36	ê.	82/150	Passive	160/4	687	Built in
16 CHENICAL RELEASE MODALE COM 1900 100 NO SEC.ATTACHED MANBHARE 17 RECOVERABLE PLASHA APP 440 - 40 56/50 Cold plate 0.236/32 + 1200		2	ulsp.	MISP	202	ŝ	1000/1000	Cold pintes	196/7000	Dey/Hight	Bady Pitg.
17 ALCOVERABLE PLASMA APDP 440 -40 50/50 Cald place 0.296/32 + 1200	FREEFLYERS	=	CHEMICAL RELEASE MODULE	5	1900	8		1-015 011	ATTACHED MARBURAL		
	LAUMCH	2	RECOVERABLE PLASSING DIAGNOSTIC PACKAGE	204	\$	0+,	05/05	Cold plate	0.294/32 + 1200	Cant.	:

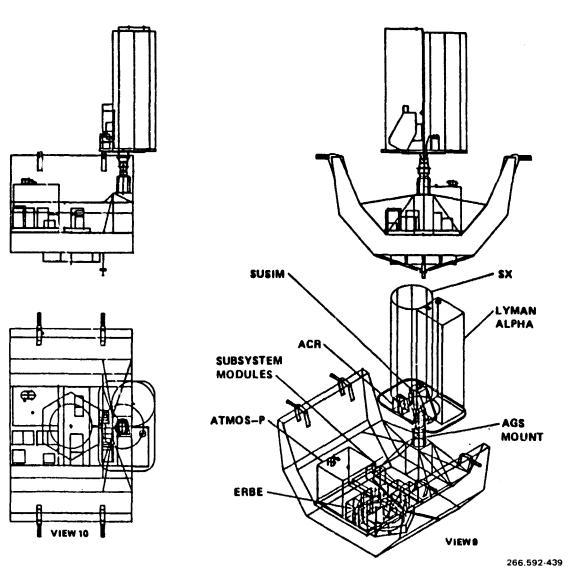
Summary of Characteristics and Requirements for STD Instruments

GDC-ASP-83-002

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Code: GDCD 0246

PAYLOAD ELEMENT SYNTHESIS

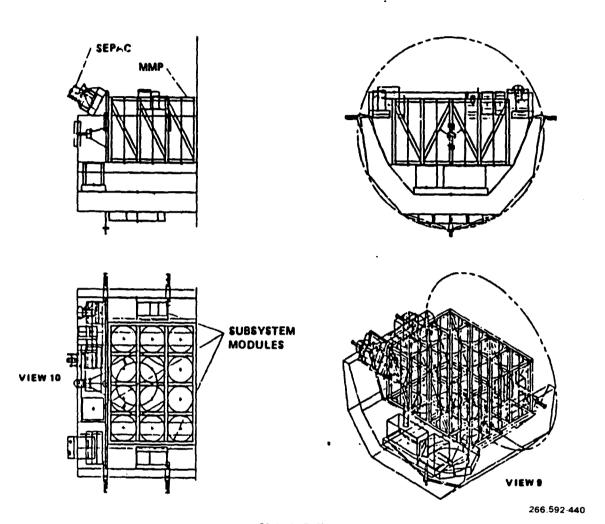


+Y Axis Pallet

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-Y Axis Pallet

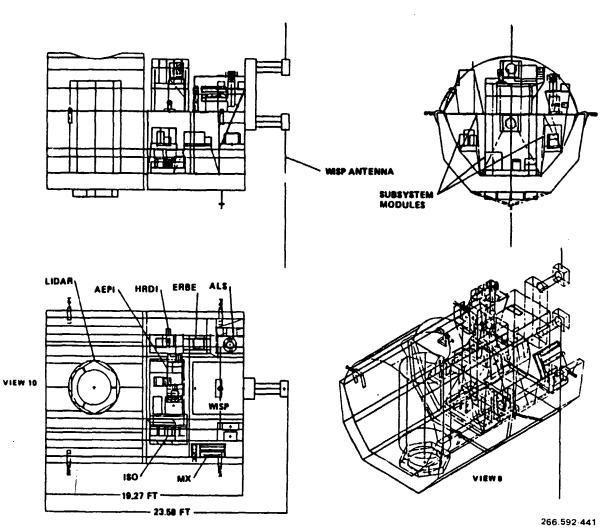
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Code: GDCD 0246

PAYLOAD ELEMENT SYNTHESIS



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		Page 1 of 3
PAYLOAD ELEMENT NAME Space Plasma Physics Pl	CODE G D C D O 2 4 7	
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division		Applications (non-commercial)
San Diego, CA 92138		- Commercial
Telephone (619) 277-8900, Ext. 3778/213u		Technology Development
STATUS Operational Planned Approved		Operations
First filight, yr 1992 No. of flights 1 Duration of Flight, days 365		(see Table A) Importance of the Space Station to
atmos nd ind		this Element 1 - low value but could use
		Scale 1 - 10 5
DESCRIPTION The SPP payload contains the following instruments: wave injection (WISP), solar monitor (ACM, SUSIM, X-ray), low light TV (AEPI), X-ray telescope (AXET), UV and visible (ISO). Subsatellites (PPDP) and multiprobes (MP) are included. The integration hardware includes an active thermal control loop, a shelf on which mounts the SEPAC electron gun, MPD arcjet, and instruments, and a special structure for mounting the WISP dipole antenna. The SPP is packaged on a spacelab pallet.	truments: wave injectior telescope (AXET), UV and The integration hardwar SEPAC electron gun, MPD dipole antenna. The SPF	truments: wave injection (WISP), solar monitor (ACM, telescope (AXET), UV and visible (ISO). Subsatellites The integration hardware includes an active thermal SEPAC electron gún, MPD arcjet, and instruments, and dipole antenna. The SPP is packaged on a spacelab

CODE 6 0 0 0 2 4 7 Page 2 of 3	150	r XEarth Field of view, deg ±40 × 90	W Duration, hrs/day 1.0 0.5 0.1 Frequency, Hz	□Other Frequency (MHZ)	X Digital
	ORBIT CHARACTERISTICS Apogee, km 500 Perigee, km 500 Inclination, deg 57 Nodal Angle, deg Escape dV Required, m/s	ING/ORIENTATI direction Sites (if kn ing accuracy, ing Stability	30 .	MUNICATIONS ng requirements! Realtime Of gption/Decryption Requirent Requirement Requirent Requirement Requirent Requirement Re	Data Types: Analog XD1(Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

CODE 6 D C D O 2 4 7
Active Passive
TIE TENOTORIANO O SOS
Heat Rejection, w operational min max
non-operational min
PHYSICAL CHARACTERISTICS
<u>></u> [
10/runction Pressurized Juphre
No. M. H. M. 10
3183
Section 1 to 1 to 1 to 1 to 1 to 1 to 1 to 1
REQUIREMENTS
Crow Size
Skills (See Table B) SKILL 3
LEVEL
Hrs/Day 0.25
Service
ALS/EVA
SERVICE: Interval, days 180 Consumables, km 2150
Man Hours
day
Returnal
Coordination with observatories on ground is required for wave infection (WISP) and narticle
Injection (SEPAC) objectives. A baseline scenario devotes one week/month of intensive operation
tional objective.

Volume II, Book 1 Appendix I

GĮ	OCD CODE	024	7	ELEME	NT NAME	SPACE	E PLASMA	PHYSICS P	AYLOAD
ΑC	COMODA	TION:	☑ ATTA	CHED	FREE	FLYER	× 🗆 0TV	OPS	
1.	STATION	ACTIVAT	TON (E.G.,	SET-UP/A	SSEMBLY	/ATTACH	MENT AND	CHECKOUT)	
	DATE(S)	1992	INT.	HRS		EVA HRS	S	EVA CREW	
									
	□ NO.	T APPLICA	ABLE						
2.	SERVICE	(E.G., RE	PLENISH/F	RESUPPLY	')				
	INTERVA	L 180	DAYS	TOTAL	SERVICES	·			
	☐ TM:	S/OTV RE	QUIRED_			s	TATION HR	S PER SERVICE	8
	□ NO	T APPLICA	ABLE _	<u> </u>		E	VA HRS PE	R SERVICE	88
						Ε	VA CREWS	IZE	_1
3.	STATION	OPERAT	IONAL SUF	PORT (A	VG. TIME I	FOR MON	ITOR, INSPE	CT, ETC.)	
			R DAY (IN						
		_	R DAY (E)						• •
		T APPLICA							
	252245								
4.	RECONFI			TOTA	, DECONE	uce			
			DAYS	IUIA	LNECOM			DEP DECOME	c
		VOTV RE						PER RECONFI	
	Z NU	T APPLICA	4865					RECONFIG.	
						Ε'	VA CREW SI	4 E	
5.	DEACTIV								
	DATE(S)	1993	INT.	HRS		EVA HRS		_ EVA CREW _	
	□ NO	T APPLICA	ABLE						
6.	NOTES (E	BRIEFLY	DESCRIBE	TASKS IN	I THROU	GH 5 ABO	OVE)		
*	Free requi	flyer re re-	accommo evaluat	datior tion of	is an fall r	alter equire	nate mod ments.	le, and if	used will
1 2 3	. Serv	above vice fo tor da	- assu r probe ta	ume sta e/satel	ition o	perati Onsuma	ons bles	·	

TOTAL EVA HRS ____8

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Code: GDCD 0247

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Space Plasma Physics Payload

Reference Documents:

1. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

This payload element is based upon the Space Plasma Physics (SPP) description originally developed for the MSFC unmanned SASP. The mission description and physical characteristics were taken directly from Ref 1, p D-14.

For this early time frame a manned accommodation is preferred although an unmanned platform in high inclination (57-90 degrees) is acceptable.

After a year of on-orbit development and operations, the instruments of this payload element become part of the STO (GDCD-0246).

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Code: GDCD 0247

PAYLOAD ELEMENT SYNTHESIS

Space Plasma Physics - SP.P.

DESCRIPTION

The SPP payloads contains the SEPAC, WISP, and AEPI instruments. The integration hardware includes an active thermal control loop, a shelf on which to mount the SEPAC electron gun, MPD arcjet, and instruments, and a special structure for mounting the WISP dipole antenna. The SPP payload is packaged on a Spacelab pallet.

INSTRUMENTS

SEPAC = Space Experiments with Particle Accelerators.

WISP = Waves in Space Plasmas.

AEPI = Atmospheric Emission Photometric Imaging.

OPERATIONAL CONSIDERATIONS

As a baseline scenario devote 1 week/month of intensive operation to SEPAC and WISP. Assuming WISP is in a passive mode while SEPAC is operating and vice versa. Provide additional operation where resources permit. Coordinated transmissions (interleaved pulses) is a SEPAC/WISP operational objective and capability to support such operation should be assessed. AEPI is included in the payload only to support SEPAC and WISP FOS. AEPI is desired for all SEPAC operations and some WISP operations. AEPI is typically pointed along the magnetic field line to look for an auroral spot.

SPECIAL CONSIDERATIONS/CLARIFICATIONS

EMISSIONS/SUSCEPTIBILITIES:

SEPAC emits an electronic beam (1-20 keV energy, 1-25 kW power), a He or Ar Magneto-plasma-dynamic arcjet (2-10 kJ pulse, 250 eV particle energy), and a neutral gas plume. WISP transmits high power plasma/radio waves in two broadcast bands, VLF (1-30 kHz) and HF (0.1-30 mHz). AEPI is sensitive to standard optical contaminants.

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Code: GDCD 0247

PAYLOAD ELEMENT SYNTHESIS

VIEWING REQUIREMENTS:

A 45 degree (half angle) avoidance cone is required for the SEPAC particle beams. The electron beam has a divergence angle of -5 degrees and is steerable with a 30 degree (half angle) cone. The WISP dipole antenna must have a clear view to space. Most SEPAC and WISP functional objectives (FOs) require pointing with respect to the geomagnetic field vector. AEPI would point along magnetic field lines to support SEPAC and AEPI FOs.

		Page 1 of 3
HAYLOAD ELEMENT NAME High Resolution Doppler Imager	CODE 6 D C D C 2 6 1	
	70.7	X Science &
CONTRCT W. Hardv/J. Peterson M7 21-9530		Acceptance of the control of the con
		7
Addrass P.0. Box 85357		
San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Technology
STATUS		Development
Operational Operational		
	•	
	nity	Tube Number 3
		(See Table A)
No. of flights 365		Importance of the
		Space Station to
OBJECTIVE		this Element
Direct measurement of middle atmosphere winds.		
		10 - Cital 110
		Scale 1 - 10 6
DESCRIPTION		
The high resolution doppler imager (HRDI) will be employed to measure doppler shift in visible emission limb. (Later part of GDCD 0265 and 0267 UARS payloads, and 0244 and 0246 STO)	e employed to measu 7 UARS payloads, an	are doppler shift in visible of 0244 and 0246 STO 1
HRDI is an imaging triple etalon Fabry-Perot interferometer fed by a two-axis gimbaled telescope. It observes absorption features of 02 and bands in the scattered light in the 10-50 km altitude range and atmospheric emission features in the 60-300 km altitude range. Veloc broadening and doppler-shift measured. Both-side viewing desired hasing besind him assurptions.	erferometer fed by d bands in the scat ares in the 60-300 e viewing desired	Perot interferometer fed by a two-axis gimbaled tele- of 02 and bands in the scattered light in the 10-50 sion features in the 60-300 km altitude range. Velocity Both-side viewing desired thesired wind mostuments

CODE 6.0.0.0.2.6.1, Page 2 of 3
TERISTICS 400 Periges, km 400 Tolerar deg 57 Tolerance + deg Ephemeris Acc
ENTA CIC LIC LIC LIC LIC
But
MMUNICATIONS Ing requirements! Extention (Extention Requirement Requirement Requirement Reto (K) Board Data Processing Requirement Reto (K)
Data Types: Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rais (KBPS)

CODE 0,0,0,0	1.2.6.1 Page 3 of 3
THERMAL ———————————————————————————————————	
EQUIPMENT PHYSICAL CHARACTERISTICS Location: Internal External Remote Equipment ID/Function Pressurized Unpressurized L,m 2 U,m 2 H,m 1 Launch mass, kg Consumables Types Acceleration sensitivity, a min	Stowed
Task Assignagnt	n/Monitor
s (Scs Table B) SKILL 3 LEVEL 2	
EUA TYES XNO ROBSON HES/FUA	
JICING/MAINTENANCE JICE:Interval, days Returnables, kg Returnables, kg JIGURATION CHANGES:Interval, day Returnables	Roq.
clons	1 /
EMISSIONS/SUSCEPTIBILITIES: Sensitive to emission or absorption in lines measured, and to deposition on optics. OPERATIONAL REQUIREMENTS: HRDI operates in daylight only. Observations are made of the Earth's limb at azimuth angles of 45 and 135° with respect to the velocity vector. Measurement of one wind component requires one scan (20 sec), one side viewing. Measurement of two wind components requires two scans span one side viewing.	spaced 136 seconds apart,

GDCD CODE <u>0261</u> E	LEMENT NAME	HIGH RE	SOLUTION	DOPPLER	IMAGER	(IRCH)_
ACCOMODATION:	ED 🗌 FR	EE FLYER*	OTV OF	rs		
1. STATION ACTIVATION (E.G., SE	T-UP/ASSEMBL	Y/ATTACHM	ENT AND CH	ECKOUT)		
DATE(S) 1990 INT. H	s	_ EVA HRS _	· · · · · · · · · · · · · · · · · · ·	EVA CREW		
				-		
☐ NOT APPLICABLE						
2. SERVICE (E.G., REPLENISH/RES	UPPLY)					
INTERVAL DAYS	OTAL SERVIC	ES	_			
TMS/OTV REQUIRED		STA	ATION HRS PI	ER SERVICE		
INOT APPLICABLE	<u></u>	EV	A HRS PER SE	ERVICE		
		EV	A CREW SIZE			
3. STATION OPERATIONAL SUPPO	RT (AVG. TIME	FOR MONIT	OR, INSPECT	, ETC.)		
0.1 HRS PER DAY (INTE	RNAL)					
HRS PER DAY (EVA						
☐ NOT APPLICABLE						
4. RECONFIGURATION						
INTERVAL DAYS	TOTAL RECOM	IFIGS				
TMS/OTV REQUIRED		STA	TION HRS PE	R RECONFIG)	-
NOT APPLICABLE		EVA	A HRS PER RE	CONFIG		
		EVA	A CREW SIZE	-		
5. DEACTIVATION/REMOVAL		•				
DATE(S) 1991 INT. HR	s	EVA HRS	E	VA CREW _		
						_
ONOT APPLICABLE						
6. NOTES (BRIEFLY DESCRIBE TA	SKS IN 1 THRC	UGH 5 ABOV	E)			
* Free flyer accommoda require re-evaluatio	tion is an n of all r	alterna equireme	te mode, nts	and if u	sed wil	1
 and 5. above - ass Periodic calibrati 	ume statio on and mon	n operat itoring	ions			

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 0261

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: High Resolution Doppler Imager (HRDI)

Reference Documents:

 Space Station NAAO Study, 14-15 September 1982 Orientation Meeting Handout at NASA Headquarters.

 Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

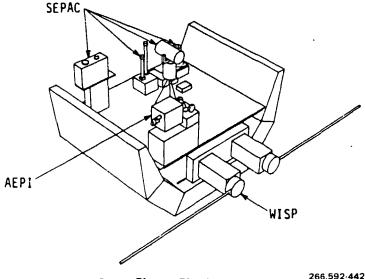
Narrative:

Payload element objectives and measurement characteristics were stated in Ref 1, p 8-26.

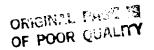
This payload is one of a number of remote sensing instruments proposed for the MSFC SASP. The physical characteristics were taken directly from Ref 2, p D-51.

After undergoing on-orbit development test for a year, the instrument is integrated into the Upper Atmosphere Research instrument group. Similar instruments are also incorporated into the Solar Terrestrial Observatory.

During developmental testing, manned interaction and access for servicing is beneficial. When mature, the instrument can be remotely operated with periodic servicing.



Space Plasma Physics Group



GDC-ASP-83-002

Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 0261

PAYLOAD ELEMENT SYNTHESIS

Example: High Resolution Doppler Imager (HRDI)

Measurements: Doppler shift in visible emissions on the limb

Objectives: Direct measurement of middle atmosphere winds

Special needs: Pointing stability and knowledge: 0.03 deg control,

0.002 deg/100 sec stability, 0.025 deg yaw knowledge

Impacts: Spacecraft design and operations

Solution: Stable platform

DESCRIPTION:

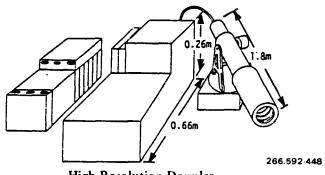
HRDI is an imaging triple etalon Fabry-Perot interferometer fed by a two axis gimbaled telescope. It observes absorption features of 0_2 and bands in the scattered light in the 10--50 km altitude range and atmospheric emission features in the 60--300 km altitude range. Velocity broadening and doppler-shift measured. Both-side viewing desired. Desired wind measurement accuracy is 5m/sec.

EMISSIONS/SUSCEPTIBILITIES:

Sensitive to emission or absorption in lines measured, and to deposition on optics.

OPERATIONAL REQUIREMENTS:

HRDI operates in daylight only. Observations are made of the earth's limb at azimuth angles of 45 and 135 degrees with respect to the veolcity vector. Measurement of one wind component requires one scan (20 sec), one side viewing. Measurement of two wind components requires two scans spaced 136 seconds apart, one side viewing.



High Resolution Doppler

ORIGINAL PAGE IS OF POOR QUALITY

		Page 1 of
PAYLOAD ELEMENT NAME Meas of Air Pollution From SAT	CODE 6 D C D Q 2 6 2	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division Address P.O. Roy 85357		Applications (non-commercial)
San Diego, CA 92138		Commercial
Telep. 2na (619) 277-8900, Ext. 3778/2130		Technology Development
SIRTUS Operational Planned Roandidate	ned Idate	Operations
	Opportunity	Type Number 3
ght, yr 1990 ights 1 of Flight, days		(see Table A) Importance of the Space Station to
OBJECTIVE To provide technology base for the development of passive remote sensors of atmospheric trace gases. (MAPS)	t of passive remote	+ 100
		Scale 1 - 10 6
DESCRIPTION For the MAPS payload modular instruments which would allow changing of components would be flown. Various tests to determine such things as optimum bandpasses, filtering and scannicould be performed for different instrument concepts and target gases. The equipment constypically of camera, optical unit, tape recorder, electronics and cold plate.	h would allow changins as optimum bandpassoncepts and target gasder, electronics and	ng of components would be es, filtering and scanning ises. The equipment consists cold plate.

G D C D D 2 6 2 Page 2 of 3	Periges, km 400 Tolerance + 200 57 Ephemeris Accuracy, m	ORIENTATION ction Inertial Solar XEarth ss (if known) accuracy, arc sec 7200 Field of view, deg ±40 Nadir Total Stability (Jitter) arc sec/sec	Duration, hrs/day 200 Power, W Duration, hrs/day idby Frequency, Hz	a XOf n Requir Rate (Ki sing Req	ypes: Analog XDigital Hrs/Day Amount) 'U (Hrs/Day) Ind Storage (MBIT) Ind Storage (MBIT) Ind Storage (MBIT)
	, ,	POINTING/ORIENTATI Usew direction Truth Sites (if kn Pointing accuracy, Pointing Stability Special Restriction	POUER Dec Operating Standby Peak	DATA/COMMUNICATIONS Monitoring requirements: None Encryption/Decryptio Uplink Req.:Command Un-Board Data Proces	Data Types! Film (Amount) Live TU (Hrs/I On-Board Store Data Dump Freq

	_
	F886 3 01 3
Passive	
5 5	max 45
non-operational	XSE
ned helperton, w operational ain	XX
PHYSICAL CHARACTERISTICS	
Location: Unternal External Remote Equipment ID/Function Dressurized Incres	
L, m 1.0 U, m 1.0	9.0
1.0	9.0
•	00
uypes thick:	
H Vhatatatanaa	HIN HOX
Craw Size 1 Task Assignment	Monitor Instruments
LEVEL 2	
Hrs/Day 0.2	
EUA X YES NO Reason Service/Reconfiguration Hr. JEIIA	100 Hr = /F114 6
SERUICE! Interval, days 90 Consumables,	χα
	•
Aup	Man/Hrs Rog. 2
Deliverabl	
SPECIAL CONSIDERATIONS/See Instructions	1
This navioad confit commoncial cost control	
Fey our court period to 1001.)	

Volume II, Book 1 Appendix I

GDCD CODE 0262 ELEMENT NAME MEA	SUREMENT OF AIR POLLUTION
ACCOMODATION: X ATTACHED TREE FLY	ER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATT)	ACHMENT AND CHECKOUT)
DATE(S) 1990 INT. HRS EVA	HRS EVA CREW
□ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	·
INTERVAL 90 DAYS TOTAL SERVICES 3	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR N	MONITOR, INSPECT, ETC.)
0.2 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	•
☐ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL 90 DAYS TOTAL RECONFIGS.	3
TMS/OTV REQUIRED	STATION HRS PER RECONFIG. 1
☐ NOT APPLICABLE	EVA HRS PER RECONFIG. 1
	EVA CREW SIZE 1
5. DEACTIVATION/REMOVAL	
DATE(S) 1991 INT. HRS EVA H	1RS EVA CREW
□ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	ABOVE)
 Station OPS Equipment servicing Monitor instruments Assume equipment changeout (filte Station OPS 	ers, sensors, etc.)

TOTAL EVA HRS 6

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 0262

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Measurement of Air Pollution from Satellites (MAPS)

Reference Documents:

- 1. Space Station NAAO Study, 14-15 September 1982 Orientation Meeting Handout at NASA Headquarters, Attachment A, p 47.
- 2. Strawman Payload Data for Science and Applications Space Platforms, Final Report, SP80-MSFC-2403, January 1980.

Narrative:

This payload element was suggested as a Technology Development Mission in Attachement A to Ref 1.

An instrument with similar objectives and capabilities was developed for Shuttle flights and proposed for use on the MSFC SASP. The instrument is dexcribed in Ref 2, p 116.

For Space Station, an instrument with similar size characteristics could be used, but the film camera would be replaced by an electronic imaging instrument. The weight and power estimates from Ref 1 were used, rather than Ref 2.

Altitude and inclination are not critical for development testing, but most useful data would be obtained in high inclination orbits.

A mature version of this instrument could be used for air pollution detection and tracking per GDCD-1001.

ORIGINAL PAGE 19 OF POOR QUALITY

GDC -ASP-83-002

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Code: GDCD 0262

PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title:

Earth Observations Instrument Development

Langley Contact: H. G. Reichle, Jr.

Experiment Title:

MAPS (Measurement of Air Pollution from Satellites)

Mission Objectives:

To provide technology base for the development of passive remote sensor of atmospheric trace gases

Mission Description:

Modular instruments which would allow changing of components would be flown. Various tests to determine such things as optimum bandpasses, flitering, and scanning could be performed for different instrument concepts and target gases.

Benefit:

Current test methods involve the use of Shuttle sortie missions for techniques development. Lead times for integration are long and available missions are very few in number causing development to be very slow. Accelerated development would allow much earlier global trace gas assessments.

Justification:

Need space environment. Wide geographical coverage affording a variety of atmospheric conditions. Ability to make instrument adjustments on orbit to optimize test results.

Mission Requirements and Capability:

Altitude and inclination not critical. Must be Earth viewing attitude (Nadir = 5°). Weights generally of order 100 kg, power of order 200 watts. Instrument thermal control required.

Space Station vs. Free Flyer:

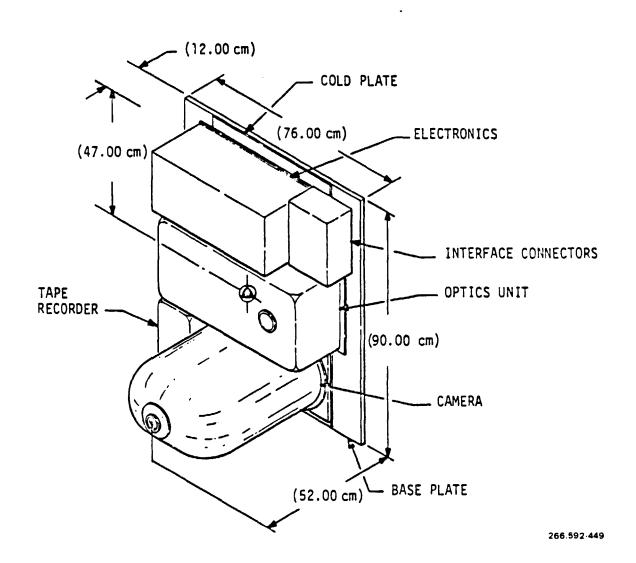
Free flyer would suffer all disadvantages of sortie mission but to an even greater degree. Free flyer would not allow easy on orbit instrument modifications, hence is not a viable alternative.

GDC-ASP-83-002

Page 3 of 3 Volume II, Book 1 Appendix I

Code: GDCD 0262

PAYLOAD ELEMENT SYNTHESIS



	Page 1 of 3
CO2 Lidar For ATMOS Gas Meas	TYPE
on MZ 21-9530 onvair Division	Applications (non-commercial)
	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	- Tachnology Develonment
STATUS Operational Operational X) Candidate	Operations
First flight, yr 1998 No. of flights 1 Duration of Flight, days 1825 OBJECTIVE	Importance of the Space Station to this Element
To provide technology for high pulse energy and high repetition rate CO ₂ lasers with high frequency stability, wide tuning range, and long laser lifetimes.	01
	Scale 1 - 10 6
DESCRIPTION This CO ₂ LIDAR for atmospheric trace gas concentration and wind velocity transport measurements payload will demonstrate the use of a high power CO ₂ LIDAR from the Space Station for global environmental atmospheric studies, and for improved weather predictions.	wind velocity transport measure- LIDAR from the Space Station for weather predictions.

TERISTICS FOR THE CODE	deg 57 gee, Km deg 60 m/s	ORIENTAL setion	accurac Stabili lestrict	orating 25,000 Power, U Duration, hrs/day	Frequency, Hz	requirements: Realtime Of Lion/Decryption Requirement Req.: Command Rate (KI rd Data Processing Req	Types: Analog Digital Hrs/Day (Amount) TU (Hrs/Day) Our Storage (MBIT) Dump Frequency (Per Orbit) rding Rate (KBPS) 250 Downlink Frequency (MHZ)
ORBIT CHARACTER	Inclination, deg Nodal Angle, deg Escape do Requi	17 23	ing accura ing Stabil	D 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Peak Voltage, V	MUNICA ng req Vption nk Req oard D	Data Types: Film (Amount Live TU (Hrs On-Board Sto Data Dump Fr

CODE 6.0.0.2.6.3		_
THERMAL Active Passive		
rics rnal Remote surized Unpressurized 4.5 U,m 4.5 H,m 4.5 L,m 4.5 H,m 4.5 kg	Stowed	
	e with GND	
so Table B) SKILL 3		
Hrs/Day		
Roas	50	
ays 180 Cc		
ESiInterval, day Dollverables, kg-	16	
Lions		

GDCD CODE 0263 ELEMEN	TNAME CO LIDAR FOR ATMOS GAS MEAS
ACCOMODATION: X ATTACHED	☐ FREE FLYER ☐ OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/AS	SSEMBLY/ATTACHMENT AND CHECKOUT)
DATE(S) 1998 INT. HRS	EVA HRS EVA CREW
NOT APPLICABLE	
. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 180 DAYS TOTALS	SERVICES 9
TMS/OTV REQUIRED	STATION HRS PER SERVICE _2
□ NOT APPLICABLE	EVA HRS PER SERVICE 2
	EVA CREW SIZE 1
0.25 HRS PER DAY (INTERNAL) HRS PER DAY (EVA) NOT APPLICABLE	, .
. RECONFIGURATION	
INTERVAL 365 DAYS TOTAL	RECONFIGS. 4
TMS/OTV REQUIRED	STATION HRS PER RECONFIG. 8
☐ NOT APPLICABLE	EVA HRS PER RECONFIG. 8
	EVA CREW SIZE1
. DEACTIVATION/REMOVAL	
DATE(S) INT. HRS	EVA HRS EVA CREW
Z M. TADDI ICADI E	
NLT APPLICABLE	
B. NOTES (BRIEFLY DESCRIBE TASKS IN	1 THROUGH 5 ABOVE)
 Station OPS Assume routine servicing Operate Assume equipment change 	·
Operations continue after	er year 2000

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 0263

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: CO₂ LIDAR for Atmospheric Trace Gas Concentration &

Wind Velocity/Transport Measurements

Reference Documents:

1. Space Station NAAO Study, 14-15 September 1982 Orientation Meeting Handout at NASA Headquarters, Attachment A, P 48.

2. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

This payload element was suggested as a Technology Development mission in Attachment A to Ref 1 p 12-75. The referenced power input of 25 kW was used.

The physical characters were derived by GDC by scaling-up to LIDAR facility described in Ref 2, p D-83.

This large CO₂ LIDAR facility is conceived as a 3-pallet train which holds the telescope, pointing mount, electronics and cooling system equipment. The pallet train is berthed to a standard port which furnishes power, cooling fluid and data bus interfaces.

Manned access is required periodically for servicing and for changing lasers and detectors.

Developmental testing can be carried out at 28.5 degrees inclination, but global weather studies require at least 57 degree orbit.

Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 0263

PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title:

Earth Observations Instrument Development

Langley Contact: R.V. Hess

Experiment Title:

CO₂ Lidar for Atmospheric Trace Gas Concentration and Wind VeTocity/Transport Measurements

Mission Objective:

To provide the technology for high pulse energy and high repetition CO₂ lasers with high frequency stability and wide tuning range and longer laser life times

Mission Description:

The mission will provide the technology for the mission objectives. Key issues are establishment of the laser characteristics in the space station environment with benefits from the manned technology laboratory

Benefit:

The availability of higher power than on the Shuttle will provide vital information for environmental atmospheric studies and for meteorology for improved weather predicition for civilian and military purposes.

Justification:

Demonstration of $\rm CO_2$ Lidar from the space station with availability of high powers, is of great importance for global environmental and meterological studies, which cannot be conducted from the ground. The experiment could also be applied to evaluation of rendezvous with non-cooperative targets

Mission Requirements and Capability:
Power requirements of 25 kw and higher

Space Station vs. Free Flyer:

Applicability of experiment to free flyer will be determined by demonstration

	Page 1 of 3
PAYLOAD ELEMENT NAME 6 0 0 0 0 2 6 4	•
W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division	MScience & Applications (non-commercial)
	- Commercial
Telephona (619) 277-8900, Ext. 3778/2130	Tachnology Development
nal	Operations
U opportunity	•
	(see Table A) Importance of the Space Station to this Element
Profiling the abundance of atomic molecular species and aerosols; collecting meteorological data (wind velocity, cloud height, temperature and pressure profiles).	1 - low value but could use 10 - vital
	Scale 1 - 10 8
DESCRIPTION The LIDAR is integrated on a spacelab type of pallet which is docked to the host platform or station. (Later to become part of Solar Terrestrial Observatory (STO) GDCD 0244 and GDCD 0246.)	ked to the host platform or (STO) GDCD 0244 and GDCD

CODE 6.0.0.0.2,6.4 Page 2 of 3
CHARACTERISTICS b, km 400 Periges, km 400 Tolerance + 33 nation, deg 57 Angle, deg Ephemeris Accuracy, m Ephemeris Accuracy, m
POINTING/ORIENTATION Usew direction Inertial Solar Earth Truth Sites (If known) Pointing accuracy, arc sec 3600 Field of view, deg Nadir Pointing Stability (Jitter) arc sec/sec
POWER Ac Donating A500 Power, W Duration, hrs/day Operating A500 Power, W Duration, hrs/day Standby Peak Peak
UNICATIONS grequirements; CRealtime 00f ption/Decryption Requir R Req.:Command Rate (Ki and Data Processing Req
Data Types: Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 253 Downlink Frequency (MHZ)

ictive X Passive (Self-Contained) ure, deg C operational min max non-operational min max ection, w operational min max	PHYSICAL CHARACTERISTICS Internal External Remote ID/Function Pressurized Unpressurized L,m 4.5 U,m 4.5 H,m 4.5 Launch mass, kg Consumables Types Acceleration sensitivity, g min	Task Assignment SKILL SKILL LEVEL Hrs/Day NO Reason Service CE 180 Consumab kys kg Boliverables, kg Doliverables, kg	
THERMAL Mactive Temperature, deg	EQUIPMENT PHYS	CREW REQUIREMENTS Crew Size Skills (See Table B SKILLS (See Table B SERVICING/MAINTENAN SERVICE: Interval, d Returnables CONFIGURATION CHANGE SPECIAL CONSIDERATI	

GE	CD CODE 0264 E	LEMENT NAME	LIDAR FAC	ILITY	
ΑC	COMODATION: 🗵 ATTACH	ED 🗆 FREI	FLYER* (OTV OPS	
1.	STATION ACTIVATION (E.G., SE	T-UP/ASSEMBLY	/ATTACHMEN	FAND CHECKOUT)	
	DATE(S) 1992 INT. HR	is	EVA HRS	EVA CREW	
	☐ NOT APPLICABLE				
2.	SERVICE (E.G., REPLENISH/RES	UPPLY)			
	INTERVAL 180 DAYS				_
	TMS/OTV REQUIRED				
	☐ NOT APPLICABLE		EVA H	RS PER SERVICE	2
			EVA C	REW SIZE	_1
3.	STATION OPERATIONAL SUPPO	RT (AVG. TIME	FOR MONITOR	, INSPECT, ETC.)	
	0.2 HRS PER DAY (INTE	RNAL)			
	HRS PER DAY (EVA)				
	NOT APPLICABLE				
4.	RECONFIGURATION				
	INTERVAL 180 DAYS	TOTAL RECONF	igs. <u>1</u>		
	TMS/OTV REQUIRED		STATIO	IN HRS PER RECONFIG	i. <u>8</u>
	☐ NOT APPLICABLE		EVA HI	RS PER RECONFIG	8
			EVA C	REW SIZE	1
_	DEACTIVATION/REMOVAL				
J .	DATE(S) 1993 INT. HR	c	EVA HDC	EVA CREW	
	UA 12/3/ IN 1. HN	s	EVA 1113		
	NOT APPLICABLE			***	,
6.	NOTES (BRIEFLY DESCRIBE TA	SKS IN 1 THROU	GH 5 ABOVE)		
*	Free flyer accommodar require re-evaluation				ed will
	. Routine servicing	e response			

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 0264

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: LIDAR Facility

Reference Documents:

- 1. Space Station NAAO Study, 14-15 September 1982 Orientation Meeting Handout at NASA Headquarters.
- 2. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

This payload element is listed as a major proposed mission in development in Ref 1, P 8-20. Examples of the mission objectives and measurement description are given in Ref 1, P 8-30.

The LIDAR facility proposed for the MSFC SASP was chosen as representative of the required mission equipment. The physical characteristics of the payload element were taken directly from Ref 2, P D-83.

The LIDAR and its support equipment are installed on a pallet which berths to a standard docking port. Manned access is required for servicing and updating.

A high inclination (57-90 degrees) orbit is desired to obtain global meteorological coverage.

The LIDAR later is integrated into the Solar Terrestrial Observatory.

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Code: GDCD 0264

PAYLOAD ELEMENT SYNTHESIS

Example: LIDAR

Measurement: Atmospheric response to laser radiation

Objectives: Sound for winds and chemical composition of the atmosphere

Special needs: 3.5 kW Power, long life laser, clean optics, global

coverage, 2000 kg

Impacts: Orbit, structure, contamination

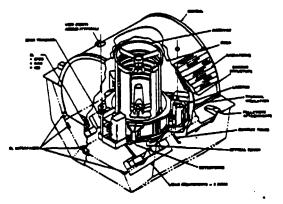
Solution: Polar orbit, large spacecraft

Page 3 of 3 Volume II, Book 1 Appendix I

Code: GDCD 0264

PAYLOAD ELEMENT SYNTHESIS

Light Detection and Ranging Facility (LIDAR)



DESCRIPTION

MASS UP/DOWN (kg): 1900/1900

SIZE (m): Dedicated SL Pallet

POWER OP./PK.(kW): 4.5

HEAT REJECTION: Active/Passive

DATA SCI./STAT.(kbps): 253/TBD

POINTING TYPE: Nadir

ACC.(deg)/STAB.(min): 1/6

OPERATING COND: TBD

ORBIT (km/deg): 300/57

FLIGHT DURATION (mo.): TBD

DESCRIPTION: LIDAR is a modular multiuser facility consisting of several elements: (1) Laser sources - Nd: Yag, Dye system, CO₂; detection packages; 1.25 meter class telescope; and controlling electronics. LIDAR will occupy a full pallet. Science objectives include profiling the abundance of atomic and molecular species and aerosols and collecting meteorological data (wind velocity, cloud height, temperature and pressure profiles). Pointing direction is mostly nadir.

EMISSIONS/SUSCEPTIBILITIES: Laser output is in the 0.2-12.0 µm spectral range. LIDAR would be sensitive to the standard range of optical contaminants effective in this spectral range. Dye laser (215-940 nm) puts out 5-200 µJ pulses at a repetition rate of 10 Hz. CO₂ laser puts out 10 J pulses at a 15 Hz repetition frequency.

OPERATIONAL REQUIREMENTS: Meaningful data may be taken over the 24-hour day. Some observations of particular target zones may be desired.

SPECIAL CONSIDERATIONS: Rediator requires view to space/sun avoidance.

NASA STO CONTACT: Bill Roberts, MSFC

REFERENCE: Solar Terrestrial Observatory Conceptual Design and Analysis Study,

March 1982

		Page 1 of 3
PAYLOAD ELEMENT NAME Upper Atmosphere Res Pl - Dev	CODE 6 D C D 0 2 6 5	TYPE
		Applications (non-commercial)
Addrass P.O. Box 85357 San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		☐ Technology Development
STATUS		Operations
,	date tunity	Type Number 3
First flight, yr 1994 No. of flights 1 1994 Duration of Flight, days 550		(see Table A) Importance of the Space Station to
OBJECTIVE Measure atmosphere composition temperature, pressure, wind velocity, solar irradiance, etc.		this Eloment 1 - low unlumbut could use 10 - vital
DESCRIPTION A special carrier structure would be utilized to satisfy the viewing requirements of the following instrument group and optimize the utilization of the envelope: ATMOSatmospheric trace molecular spectrometer, HALOE-Halogen ocultation Exp, TWM-Temp wind measurement in atmosphere and lower thermosphere, .CLAES-cryogenic limb array Etalon spectrometer, ISAMS-Improved stratosphereic and mesopheric sounder, MSL-microwave limb irradiance sounder, HRDI-high resolution doppler imager, USSIE, UV solar spectral irradiance EXP, SUSIM-solar UV spectral irradiance monitor.	Jld be utilized to sa otimize the utilizati DE-Halogen ocultatior AES-cryogenic limb ar sounder, MSL-microwav I solar spectral irra	ial carrier structure would be utilized to satisfy the viewing requireginstrument group and optimize the utilization of the envelope: ATMOSecular spectrometer, HALOE-Halogen ocultation Exp, TWM-Temp wind measured lower thermosphere, .CLAES-cryogenic limb array Etalon spectrometer, sphereic and mesopheric sounder, MSL-microwave limb irradiance sounder, doppler imager, USSIE, UV solar spectral irradiance EXP, SUSIM-solar UV initor.

Tolerance + 200 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Earth +45 Nadir - Also Limb Flold of view, deg 60°-90° El. 0°-360° AZ	Duration, hrs/day 12 Continuous Cy, Hz	Other Frequency (MHZ)	Voice (Hrs/Day) Other Downlink Frequency (MHZ)
TERISTICS 400 Periges, km 400 deg 57 deg 67 quired, m/s	TON Inertial Solar ing 4000 Power, U 2000 Frequen	HUNICATIONS ng requirements! Reaitime □0f Uption/Dacryption Requirent Requirement	Data Types: Analog Digital OH Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 500 Downlink	

Temperature, deg C operational min max non-operational min 825 max non-operational min 825 max heat Rejection, w operational min max non-operational min max EQUIPMENT PHYSICAL CHARACTERISTICS Coction: Unternal External Remote Equipment ID/Function Pressurized Unpressurized Stowed
CHARACTERISTICS rnal External Remote for Pressurized Unpressurized L.m 4.5 U.m 4.5 H.m 2
kg 2500 Types Types anstituttu, a min max
Task Assignment Calibration
Skills (Soe Table B) SKILL 4 5 Skills (Soe Table B) LEUEL 3 2
0.4
MAINTENANCE 225 CONTRACTOR PARTICIPATION NOT SELECT
kg Interval, day Deliverables, kg.
lons EMISSIONS/SUSCEPTIBILITIES: Cr ve to absorption, emission, or scatte optics, and microwave interference to t dawn/dusk. The remaining instrument perate on the night side. Solar obse USSIE. USSIE also requires occasional g instruments require global coverage

GDCD CODE 0265 ELEMENT NAM	E UPPER ATMOS. RES.	PAYLOAD DEVELOPMENT
ACCOMODATION: ATTACHED F	REE FLYER	
1. STATION ACTIVATION (E.G., SET-UP/ASSEMB	LY/ATTACHMENT AND CHEC	KOUT)
DATE(S) 1994 INT. HRS	EVA HRS E	A CREW
☐ NOT APPLICABLE		
2. SERVICE (E.G., REPLENISH/RESUPPLY)		
INTERVAL 225 DAYS TOTAL SERVI		
TMS/OTV REQUIRED	STATION HRS PER	SERVICE 6
NOT APPLICABLE	EVA HRS PER SER	VICE 6
	EVA CREW SIZE	1
3. STATION OPERATIONAL SUPPORT (AVG. TIN	E FOR MONITOR, INSPECT, E	TC.)
0.8 HRS PER DAY (INTERNAL)		
HRS PER DAY (EVA)		
☐ NOT APPLICABLE		
4. RECONFIGURATION		
INTERVAL 225 DAYS TOTAL RECO	NFIGS. 1	
TMS/OTV REQUIRED	STATION HRS PER	RECONFIG. 12
☐ NOT APPLICABLE	EVA HRS PER RECO	NFIG. 12
	EVA CREW SIZE	1
5. DEACTIVATION/REMOVAL		
DATE(S) 1996 INT. HRS.	EVA NOV EVA	
IN 1. HNS.	EVA NNS EVA	
□ NOT APPLICABLE		
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THR	DUGH & AROVE)	
	304n 3 A80VC/	
 Station OPS Replace cryogenics 		
3. 2 crew @ 0.4 hrs. each		
 Assume equipment update Station OPS 		

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Code: GDCD 0265

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Upper Atmosphere Research Payload - Development

Reference Documents:

1. Space Station NAAO Study, 14-15 September 1982 Orientation Meeting Handout at NASA Headquarters.

2. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

This mission is listed as a major proposed mission in Ref 1, P 8-20. Status of the UAR satellite is given on pp 8-9 of Ref 1. The satellite is proposed for launch in 1988.

A group of experiments (UARS E) with similar objectives and measurement requirements is given in Ref 1, pp 8-23.

The group of instruments was further defined for accommodation on the MSFC SASP. The instruments, mounting structure and integration hardware are described in Ref, 2 p D-46. This payload element description was taken directly from this latter reference, although the actual instruments would be 2nd generation models.

The instrument group is flown on a manned space station for a one year development period where manned access is required for adjustments, servicing, and interchanging detectors and other active elements.

The instruments are later flown operationally on a high inclination orbiting platform or space station.

Launch schedule and mission duration were derived.

Page 2 of 6 Volume II, Book 1 Appendix I

Code: GDCD 0265

PAYLOAD ELEMENT SYNTHESIS

Upper Atmosphere Research Satellite (UARS) Status

Objective: Obtain integrated global measurements of upper

atmosphere composition, dynamics, and energy input

kecommended By: Space science board

Committee on solar terrestrial relationships

Study Phase Scientific working group October 1977 - July 1978

Ad Released: September 15, 1978

Preliminary Selection: April 1980 (16 experimental & 10 theoretical

investigations)

Phase B Instrument Studies: May 1980 - November 1981

Final Selection: November 1981 (9 experimental & 10 theoretical

investigations)

Start: Experiments and mission studies: FY1982 Space-

craft and ground segments: FY1984 candidate

Launch: Fall 1988

Center: Goddard Space Flight Center

Configuration: One spacecraft in 600 km, 57 degree orbit,

18-month lifetime

Measurements: Visible, infrared, ultraviolet, and microwave

observations of the Earth's limb, UV Nadir sounding for

ozone, UV solar and stellar observations.

Objectives: Understand the coupling of dynamics, energetics and

composition of the stratosphere

Special Needs: Simultaneous viewing of Nadir, both limbs, sun, and limb 45

degrees of satellite, massive payload (2000KG), solid hydro-

gen cryogen (10 K), global coverage at limb

Impacts: One instrument lifetime limited (18 months), orbits of roughly

no a fact of miles

70 degree inclination, satellite size

Solution: Unique free flyer

GDC -ASP -83-002

Page 3 of 6 Volume II, Book 1 Appendix I

Code: GDCD 0265

PAYLOAD ELEMENT SYNTHESIS

DESCRIPTION

Payload contains UARS instrument group (HALOE, THM, CLAES, ISAMS, MLS, HRDI, USSIE, AND SUSIM) plus integration hardware. It is anticipated that a special carrier structure would be utilized witch would satisfy the viewing requirements of the instrument group and optimize utilization of the Orbiter cargo envelope.

ORBIT CHARACTERISTICS

Altitude (km): 400 Inclination (deg): 57

Other requirements:

EMISSIONS/SUSCEPTIBILITIES

Cryogen system on CLAES vents hydrogen. The payload is sensitive to absorption, emission, or scattering through the spectrum (UV through IR), deposition on optics, and microwave interference to (MLS).

VIEWING REQUIREMENTS

The parload requires viewing in multiple directions: solar, solar occultation, stars, earth limb cross track (one side and both sides), and earth's limb at 45 and 135 degrees from the velocity vector on one side.

OPERATIONAL CONSIDERATIONS

HALOE operates at dawn/dusk. The remaining instruments all operate on the day side of the orbit and some also operate on the night side. Solar observations are required at least once per day by SUSIM and USSIE. USSIE also requires occassional observations of stars for calibration. The atmosphere viewing instruments require global coverage as continuously as possible.

STS INTERFACES

10 1 Mars 11 11 71 15

Cryogenic system on CLAES may require monitoring for safety.

266.592.452

Payload for Upper Atmosphere Research Satellite (UARS)

Page 4 of 6 Volume II, Book 1 Appendix I

Code: GDCD 0265

PAYLOAD FLEMENT SYNTHESIS

Upper Atmosphere Research Project

HALOE Halogen Occultation Experiment

Limb - Solar occultation - 2 axis gimbal.

TWM Temperature and Wind Measurement in the Mesosphere and

Lower Thermosphere Limb

CLAES Cryogenia imb Array Etalon Spectometer (Limb

pointing)

ISAMS Improved Stratospheric and Mesospheric Sounder

Limb scanning

MLS Microwave Limb Sounder

Line

HRDI High Fasolution Doppler Imager

Limb - 2 axis glimbal

USSIE Ultraviolet Solar Spectral Irradiance Experiment

Solar pointing - mount on pointing platform

SUSIM Solar Ultraviolet Spectral Irradiance Monitor

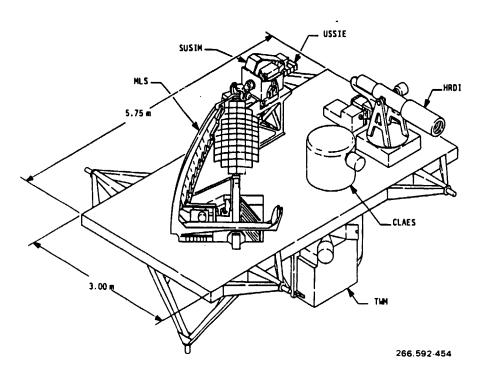
Solar pointing - mount on pointing platform

GDC-ASP-83-002

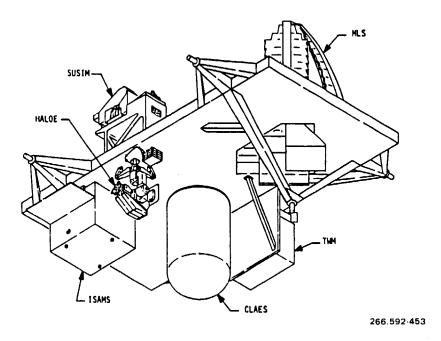
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Code: GDCD 0265

PAYLOAD ELEMENT SYNTHESIS



Upper Instruments



Lower Instruments

Page 6 of 6 Volume II, Book 1 Appendix I

Code: GDCD 0265

PAYLOAD ELEMENT SYNTHESIS

	MASS (kg)	POWER (W)	ATC		ATA (kbps)	1
ITEM	UP/DOWN	OP./PEAK	(M)	SCI	STATUS	CMD
SCIENCE INSTRUMENTS: HALOE THM CLAES ISAMS MLS HRDI USSIE SUSIM	96 65 450/430 85 234 76 8	65/96 47/TBD 20/TBD 125/TBD 470/TBD 82/TBD 5/TBD 100/TBD	Passive Passive Passive (400) Passive Passive Passive	4.0 1.1 3.0 0.6 4.1 4.0 0.064 1.0	TBD TBD TBD TBD TBD TBD TBD	(0.5)*
INTEGRATION HARDWARE: Signal Interface Unit (2) Power Interface Unit (1) Freon Pump Package S/S Coldplate Experiment Coldplate (1) CARRIER: Special Carrier	20 40 63 14 22	50 50 325	50 50 325	•	TBD TBD TBD	TBD TBD TBD
Berthing Adapter Assembly PAYLOAD TOTALS	2367/2347	1339/TBD	(825)	18	(2)	(0.6)

^{*} in CMD column indicates ancillary data

266.592-455

Table of UARS Payload Characteristics

^() TBE estimate

		Page 1 of
PAYLOAD ELEMENT NAME G. G. G. G. G. G. G. G. G. G. G. G. G.) E 0 c 0 0 2 6 6	•
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division		Applications (non-commercial)
San Diego, CA 92138		□ Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Tachnology Development
na l		Operations
Unpproved Opportunity	a ty	
First flight, yr 1995 No. of flights 1 Duration of Flight, days 3285		(see Table A) Importance of the Space Station to
		ب
Measure wind vector profiles using doppler Lidar, to allow accurate world-wide forecast to be made 5 days in advance.		1 " low value but could use 10 = vital
		Scale 1 - 10 7
DESCRIPTION		
WINDSAT is a dedicated, free-flying spacecraft that carries a doppler Lidar wind measurement system. Global coverage is required.	nat carries a dopp	ler Lidar wind measurement

Page 2 of 3			Linuous		
CODE 6 D C D 0 2 6 6 Page	CHARACTERISTICS a, km 800 Periges, km 800 Tolerance + nation, deg (Sun Synch) Ephemeris Accuracy, m		AC Seratin Sak	DATA/COMMUNICATIONS Monitoring requirements: None	Data Types: Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)
į	ORBIT Apoge Incli Nodel	アコナキュ	POUER OF S		Igrījog

ORIGINAL PASS TO OF POOR QUALITY

PHYSICAL CHARACTERISTICS Internal External Scenote ID/Function A.5 U,m 4.5 H,m 4.5 L,m 4.5 U,m 4.5 H,m 4.5 Lum A.5 U,m 4.5 H,m 4.5 Lumch mass, kg Consumables Types Acceleration sensitivity, g min max REMENTS Task Assignment Task Assignment Task Assignment Task Assignment EUEUE Hrs/Day XNO Reason MAINTENANCE Task Assignment Task Assignment MAINTENANCE Task Assignment Assignm	Passive non-operational min max operational min max non-operational min max non-operational min max
Task Assignment B) SKILL LEUEL Hrs/Day ANCE Aays Bs, kg AGES!Interval, day Deliverables, kg Deliverables, kg TIONS/See Instructions	PHYSICAL CHARACTERISTICS Internal External XRemote ID/Function PressurizedXUnpressurized 4.5 L,m 4.5 U,m 4.5 U,m 4.5 Launch mass, kg Consumables Types
MESTILL LEVEL Hrs/Day ANCE Ang days Bs, kg Ang Boliverables, kg Deliverables, kg Deliverables, kg TIONS/See Instructions	REQUIREMENTS Size Task Assignment
MNO Reason Hrs/EUA ANCE 730 Consumables, kg 16 Bs, kg Man Hours Man/Hrs Req. Deliverables, kg Returnables, IONS/See Instructions	B) SKILL LEVEL Hrs/Dau
days 730 Consumables, kg 16 ———————————————————————————————————	NO Reason
CONSIDERATIONS/See Instructions	days 730 Consumables, kg 16 Man Hours Man/Hrs Requestinterval, day
	CONSIDERATIONS/See Instructions

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 0266 ELEMENT NAM	AE WINDSAT
ACCOMODATION: 🗆 ATTACHED 🖸 F	REE FLYER
1. STATION ACTIVATION (E.G., SET-UP/ASSEME	SLY/ATTACHMENT AND CHECKOUT)
DATE(S) 1995 INT. HRS	EVA HRS EVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 730 DAYS TOTAL SERVI	CES3
TMS/OTV REQUIRED	STATION HRS PER SERVICE 16
□ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
HRS PER DAY (INTERNAL) HRS PER DAY (EVA) NOT APPLICABLE RECONFIGURATION INTERVAL DAYS TOTAL RECO TMS/OTV REQUIRED NOT APPLICABLE	ONFIGS. STATION HRS PER RECONFIG. EVA HRS PER RECONFIG. EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
OATE(S) INT. HRS	_ EVA HRS EVA CREW
MOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THR	OUGH 5 ABOVE)
1 Station OPS	

- Station OPS
 Resupply cryogenics
 Operation continues after year 2000

Page 1 of 1 Volume II, Book 1 Appendix I

Code: GDCD 0266

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: WINDSAT

Reference Documents:

1. Space Station NAAO Study, 14 & 15 September 1982 Orientation Meeting Handout at NASA Headquarters

2. NASA TM 82435, "Accommodation Assessment - Spaceborne Doppler Lidar-Wind Measuring System", August 1981.

Narrative:

This mission is listed as a major proposed initiative in Ref 1, pp 8-20. The mission objectives and measurement needs are listed in Ref 1, pp 8-12.

Conceptual studies of the doppler LIDAR system and the total spacecraft have been performed by LMSC and MSFC, respectively. The physical characteristics of the WINDSAT used in this payload element description were taken directly from Ref 2.

The 800 km, sun synchronous orbit requirement dictates that this be a free-flyer mission. Servicing/updating at 2-year intervals is envisioned. Since the spacecraft described has no propulsion subsystem, it is a candidate for TMS emplacement and retrieval. Alternatively, it could be redesigned to be supported by a Leasecraft bus with self-contained propulsion.

The launch schedule and mission duration were derived by GDC, based on a 4-year development program following a 1988 new start (Ref 1).

WINDSAT

Objective: Measure wind vector profiles using doppler lidar

Measurement Needs: Global coverage for one year plus

1 km vertical resolution to >15 km altitude

1 M/S accuracy in wind speed

Study Phase: NASA and NOAA feasibility studies completed 1982

Start: 1988 new start

CODE CODE CODE		Page 1 of 3
CONTACT N. Ha-dy/J. Peterson Nr 21-9530 Addrass Addrass Addrass Addrass Addrass Addrass Addrass Addrass Addrass Addrass Addrass San Diego, CA 92138 San Diego, CA 92138 San Diego, CA 92138 Telephone (619) 277-8300, Ext. 378/2130 Special operations Commercial Copportunity First flight, yr 1994 No. of flights Importance of the Could use Burstion of flights Importance of the Could use Special operation temperature, pressure, wind velocity, solar irradiance, etc. (This is the operational version of the "development" payload described in GDCD 0265.) DESCRIPTION A free-flyer structure (satellite) would be utilized to satisfy the viewing equirements of the following instrument group and optimize the utilization of the envelope: ATMOS-atmospheric trace molecular spectrometer, HALOE-Halogen ocultation fibe array Etalon septrometer, ISAMS-impoved stratospheric and messospheric sounder, MSL-microwave limb sounder, HRDI-high resolution doppler imager, USSIE, UV solar spectral irradiance Exp. SUSIM-solar UV spectral irradiance monitor.	ELEMENT NAME OSphere Res Pl - OPRN G D C D O 2 6	TVPE
Telephone (619) 277-8900, Ext. 3778/2130 Telephone (619) 277-8900, Ext. 3778/2130 STATUS Characterical Deparations Characterical Deparations Characterical Deparations Characterical Deparations Characterical Deparations First filight, yr 1994 No. of filights 1	ACT	Applications (non-commercial)
Telephone (619) 277-8900, Ext. 3778/2130 STATUS Operational Delanned Opportunity Candidate Opportunity First filght, yr 1994 No. of filght, yr 1994 No. of filght, yr 1994 Enemals of filght, yr 1994 No. of filght, yr 1994 No. of filght, yr 1994 No. of filght, yr 1994 No. of filght, yr 1994 No. of filght, yr 1994 No. of filght, gr 1994 Importance of the following in the operational version of the inversion of the operation opposition opp	P.O. Box San Diego	
Operational Operational Operations	0 10	- Technology Development
First flight, yr 1994 No. of flights 1460 Duration of Flight, days 1460 OBJECTIVE Measure atmosphere composition temperature, pressure, wind velocity, solar irradiance, etc. (This is the operational verecould use sion of the "development" payload described in GDCD 0265.) DESCRIPTION A free-flyer structure (satellite) would be utilized to satisfy the viewing requirements of the following instrument group and optimize the utilization of the envelope: ATMOS-atmospheric trace molecular spectrometer, HALOE-Halogen ocultation Exp, TWM-temp wind measurement at atmosphere and lower thermospheric sounder, MSL-microwave limb sounder, HRDI-high resolution doppler imager, USSIE, UV solar spectral irradiance Exp, SUSIM-solar UV spectral irradiance monitor.	Operational	rations
Measure atmosphere composition temperature, pressure, wind velocity, solar irradiance, etc. (This is the operational version of the "development" payload described in GDCD 0265.) Scale 1 - 10 8 MSESCRIPTION A free-flyer structure (satellite) would be utilized to satisfy the viewing requirements of the following instrument group and optimize the utilization of the envelope: ATMOS-atmospheric trace molecular spectrometer, HALDE-Halogen ocultation fxp, TWM-temp wind measurement at atmosphere and lower thermosphere, CLAES-cryogenic Limb array Etalon septrometer, ISAMS-improved stratospheric and mesospheric sounder, MSL-microwave limb sounder, HRDI-high resolution doppler imager, USSIE, UV solar spectral irradiance Exp, SUSIM-solar UV spectral irradiance monitor.	yr 1994 1 1 1460	
DESCRIPTION A free-flyer structure (satellite) would be utilized to satisfy the viewing requirements of the following instrument group and optimize the utilization of the envelope: ATMOS-atmospheric trace molecular spectrometer, HALOE-Halogen ocultation Exp, TWM-temp wind measurement at atmosphere and lower thermosphere, CLAES-cryogenic Limb array Etalon septtrometer, ISAMS-improved stratospheric and mesospheric sounder, MSL-microwave limb sounder, HRDI-high resolution doppler imager, USSIE, UV solar spectral irradiance Exp, SUSIM-solar UV spectral irradiance monitor.		1 - low value but could use 10 - vital
DESCRIPTION A free-flyer structure (satellite) would be utilized to satisfy the viewing requirements of the following instrument group and optimize the utilization of the envelope: ATMOS-atmospheric trace molecular spectrometer, HALOE-Halogen ocultation Exp, TWM-temp wind measurement at atmosphere and lower thermosphere, CLAES-cryogenic Limb array Etalon sepctrometer, ISAMS-improved stratospheric and mesospheric sounder, MSL-microwave limb sounder, HRDI-high resolution doppler imager, USSIE, UV solar spectral irradiance Exp, SUSIM-solar UV spectral irradiance monitor.		}
	DESCRIPTION A free-flyer structure (satellite) would be utill quirements of the following instrument group and optimize the u ATMOS-atmospheric trace molecular spectrometer, HALOE-Halogen or measurement at atmosphere and lower thermosphere, CLAES-cryogen ter, ISAMS-improved stratospheric and mesospheric sounder, MSL-high resolution doppler imager, USSIE, UV solar spectral irradiance monitor.	zed to satisfy the viewing re- ilization of the envelope: ultation Exp, TWM-temp wind c Limb array Etalon sepctrome- icrowave limb sounder, HRDI- nce Exp, SUSIM-solar UV spec-

5		72	_		
CODE 6 0 0 0 2 6 7 Page 2 of 3	0002	±45 Nadir - Also Limb 60-90 EL, 0°-360° Az	Continuous	Frequency (MHZ)	(MHZ)
CODE 6.0.0	ORBIT CHARACTERISTICS Apogee, km 400 Tolerance + 2 Inclination, deg 57 Nodal Angle, deg Escare d' Regulred.m/s	TON Solar Earth hown) ,arc sec 36 Field of view, deg. y (Jitter)arc sec/sec	ac andby	UNICATIONS grequirements! Realtime Offline Other ption/Decryption Required k Req.:Command Rate (KBS) and Data Processing Required iption	Data Types: Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 500 Downlink Trequency (MHZ)

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6 0 C 0 0 2 6 7 Page 3 of	S Remote ized Unpressurized 2 4.5 H.m 2 2500 I Cryagenics		ously as possible.

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

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GDCD CODE	0267 ELEMENT NA	ME UPPER ATM	10S INST.	RES P/L	-OPERATIONAL	
ACCOMODATION:	☐ ATTACHED 🖾	REE FLYER	OTV OPS			
1. STATION ACTIV	ATION (E.G., SET-UP/ASSEM	BLY/ATTACHMEN	IT AND CHECK	(OUT)		
DATE(S)199	4 INT. HRS	EVA HRS	EV	A CREW		
				_		
☐ NOT APPLI	CABLE					
2. SERVICE (E.G., R	IEPLENISH/RESUPPLY)					
INTERVAL 600	DAYS TOTAL SERV	ICES 1	•			
☑ TMS/0TVX	SOWARA ALTERNATE	STAT	ION HRS PER	SERVICE	16	
□ NOT APPLI	CABLE	EVA	HRS PER SERV	/ICE		
		EVA (CREW SIZE	_		
3. STATION OPERA	TIONAL SUPPORT (AVG. TI	ME FOR MONITOR	R, INSPECT, ET	rc.)		
HRS 1	PER DAY (INTERNAL)					
• •	PER DAY (EVA)	•				
図 NOT APPLI	CABLE					
4. RECONFIGURAT	TION					
	DAYS TOTAL REC	ONFIGS.				
☐ TMS/OTV R			——— On hrs per r	RECONFIG.		
☑ NOT APPLI	CABLE		RS PER RECO	_		
		EVA C	REW SIZE			
5. DEACTIVATION/	REMOVAL					
	INT. HRS	EVA HRS	FVA	CREW		
JA 1 E 10/				J.,,		
□ NOT APPLI	CABLE					
6. NOTES (BRIEFLY	CONTRACTOR OF THE CONTRACTOR O	ROUGH 5 ABOVE)				
This payload type spacecra	element assumes a aft which has orbi	ccommodation t transfer p	on a pla	tform or	· Leasecraft	
 Station (Cryogenic Assume St 	s resupply					

TOTAL EVA HRS 0

(J)

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Code: GDCD 0267

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Upper Atmosphere Research Payload - Operational

Reference Documents:

1. Space Station NAAO Study, 14-15 September 1982 Orientation Meeting Handout at NASA Headquarters

2. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations SStudy, SP82-MSFC-2583, March 1982.

Narrative:

This is an operational version of GDCD-0265.

Following a 1-year development flight on a manned space station, the instrument group is flown on a high inclination orbit platform or manned space station. The weight is for instrument package only; a Leasecraft type spacecraft would be required to provide orbit transfer propulsion, and support resources.

Manned presence would be desireable, but the instruments could be remotely operated with periodic manned servicing. The CLAES would require expanded capacity of its cryogenic cooling supply to extend its operating time from 18 to 24 months.

The launch schedule, servicing intervals and mission duration were derived by GDC.

Section 1.4
Discipline Life Sciences

GDCD ID NO.	PAYLOAD ELEMENT NAME
	BIOLOGICAL SCIENCE
0300	Human Research Laboratory
0301	Animal and Plant Research Laboratory
	OPERATIONAL MEDICINE
0322	EVA Performance and Productivity
	LIFE SUPPORT
0340	H ₂ O/O ₂ /CO ₂ /N ₂ Regenerative Systems
0341	CELSS Experimental Systems
0342	Dedicated CLSS Module
0343	CELSS Pallet

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Human Research Laboratory CONTACT W. Hardy/J. Peterson MZ 21-9530	
earch Laboratory W. Hardy/J. Peterson MZ 21-9530	TYPE
W. Hardy/J. Peterson MZ 21-9530	× 100 × 100
	Applications (non-commercial)
Haarass P.O. Box 85357 San Diego, CA 92138	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Technology
STATUS	
na l ⊠[Operations
- Approved - Candidate - Opportunity	Type Number 4
First flight, ur 1990	(see Table A)
No. of flights 1 3600 Duration of Flight, days	Importance of the Space Station to
h laboratory for experiments in	this Eloment
	4:4
perational medical problems and to elucidate	10 - vital
basic mechanisms of adaptation to spaceflight.	10
	AT T BIB36
Press module containing instr, equip, and supplies to support human physiological, psychological, and clinical technology research in: 1) human perf assessment, incl psychomotor, neurosensory, vestibular research: 2) medical care tech, incl 0g verif of surgical and orthopedic procedures (see 0301) new equip; 3) bone/calcium metaabolism, incl on-board blood, urine, fecal analysis, noninvasive bone density mineral analysis, bone biopsy instr; 4) lean body metabolism, incl balance studies, other dietary, biochemical hormonal studies; 5) cardiovasular/pulmonary physiology, incl CV stressordevices, noninvasive instr for monitor cardiac elect-mech behavior, respiratory gas monitor; 6) endocrinology, incl meas of homonal response to stress of space; 7) hematology/immunology, incl onboard analysis of blood constituents lymphatic system; 8) rad effects (see 0301) envir and personal rad monitor long term med statistical analyses	ological, and clinical ular research: 2) medi- 3) bone/calcium meta- alysis, bone biopsy 1 studies; 5) cardio- diac elect-mech behavior, ace; 7) hematology/ (see 0301) envir and

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CODE 6.0.0.3.0.0 Page 2 of 3	ص ^ر
ORBIT CHARACTERISTICS Apogee, km Any Perigee, km Any Tolerance + Inclination, deg Any Ephemeris Accuracy, m Escape du Required.m/s	- 1 1 1 -
ENTA	
accurac Stabili	
Operating 2000 Power, W Duration, hrs/day Standby 3000 Frequents H7	
NS oments! Realtime XOf	
Encryption/Decryption Required Uplink Req.:Command Rate (KBS) On-Board Data Processing Required Description 128 KBPS to On-board Computer(s); 64 KBPS Downlink 1 Hr/Day	
Data Types! Analog NDigital Mhrs/Day 8 Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT)	
Lap r	

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CODE 6.0 C. D. O. 3.0 0 Page 3 of 3
min 20 max 24
Heat Rejection, w operational min 1000 max 3000 non-operational min max
S L CRemote Ized Unpressurized
mass, xg ables Types retion sensitivitu, g m
Human Physiologic
SKILL SKILL LEUEL
ay 4
EUA TYES XNO Reason Hrs/EUA
Consumables,
CONFIGURATION CHANGES Interval, day 720 Man/Hrs Roq. 40
lons
Of the experiments performed over 10 years, 20 of these will include the human research payload as a primary emphasis; crew time, power, and data shown here represents the primary emphasis mission in the early years; later years crew time increases to 16 m-hr/day total; heat projection is for payload elements only, Not module systems. Size includes module accommodation.
יליינייין יוניומנין יווניומנין יווניומנין יווניומנין יווניומנין יווניומנין

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 0300 ELEMENT NAME	HUMAN RESEARCH LAB
ACCOMODATION: 🛭 ATTACHED 🔲 FREE	FLYER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY	ATTACHMENT AND CHECKOUT)
DATE(S) 1994 INT. HRS	EVA HRS EVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 90 DAYS TOTAL SERVICES	40
TMS/OTV REQUIRED	STATION HRS PER SERVICE
NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME (FOR MONITOR, INSPECT, ETC.)
10 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
□ NOT-APPLICABLE	
4. RECONFIGURATION	
INTERVAL 720 DAYS TOTAL RECONF	rigs. 4
☐ TMS/QTV REQUIRED	STATION HRS PER RECONFIG. 40
□ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/RÉMOVAL	
DATE(S) INT. HRS.	EVA HRS EVA CREW
■ NOT APPLICABLE	
_	C
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROU	GH 5 ABOVE)
 Station OPS Assume time included under st 	eation operations
3. Operation of equipment + act	
4. Update of equipment	•

TOTAL EVA HRS 0

Page 1 of 4 Volume II, Book 1 Appendix I

Code: GDCD 0300

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Human Research Library

Reference Documents:

- Biomedical Results from Skylab; edited by R.S. Johnson and L.F. Dietlein, Scientific and Technical Information Office, NASA, Washington, DC, NASA SP-377, 1977
- Operational Medicine Support to Long Duration Manned Missions in Low Earth Orbit and Beyond; edited by S. Furukawa, M.D., Operational Medicine Office, Life Sciences Division (EB-3) Space Science and Applications, NASA Headquarters, Washington, DC, February 1982
- 3. Foundations of Space Biology and Medicine, Volume III, Space Medicine and Biotechnology; edited by M. Calvin (USA) and O.G. Gazenko (USSR); Scientific and Technical Information Office, NASA, Washington, DC 1975. (Chapter 17, An Appraisal of Future Space Biomedical Research by S.P. Vinograd, NASA Washington, DC)
- 4. Space Station Needs, Attributes and Architectural Options; Contractor Orientation Meeting, September 14 & 15, 1982; Section 6, Life Science Concerns for Space Station, briefing by W.P. Bishop, 14 September 1982
- 5. Life Sciences Considerations for Space Station, Life Sciences Division (EB-3), Office of Space Science and Application, NASA, Washington, DC 20546. September 14, 1982
- 6. Life Sciences Research and the Science and Applications Space Platform, E.W. Gomersall, Coordinator, Biosystems Division, Ames Research Center, February 1982
- 7. Life Sciences Experiments for a Space Platform/Station; J.D. Fabricant, University of Texas, Medical Branch, Galveston Texas; Society of Automotive Engineers Technical Paper 820834, Twelfth Intersociety Conference on Environmental Systems, San Diego, July 1982
- 8. Life Sciences Mission Requirements Document (Draft) edited at Ames Research Center, November 1982
- 9. Life Sciences Flight Experiments Program, Mission Science Requirements Document for The First Life Sciences Dedicated Spacelab Mission (Parts I & II): J.A. Rummel, Johnson Space Center Report 18295, 1 June 1982.
- 10. Medical Operations and Life Sciences Activities on Space Stations; edited by P.C. Johnson and J.A. Mason, NASA TM 58248, Johnson Space Center, October 1982

Page 2 of 4 Volume II, Book 1 Appendix I

Code: GDCD 0300 PAYLOAD ELEMENT SYNTHESIS

- 11. Spacelab Mission 4, Mission Definition Study Report Summary; Study Manager, M.J. Harnage, Jr., Johnson Space Center, November 1982
- 12. Future Directions for the Life Sciences in NASA; A Report of the Life Sciences Advisory Committee of the NASA Advisory Council; edited by G.D. Whedon, Chairman, Life Sciences Advisory Committee, NASA, November 1979.
- 13. Life Beyond the Earth's Environment, The Biology of Living Organisms in Space, edited by N.S. BRicker and L.G. FIne, National Academy of Sciences, 1979
- 14. Life Sciences Laboratory Equipment (LSLE) Handbook, Johnson Space Center, 1981
- 15. Space Station User Fact Sheets and Contact Reports (attachments to letter to W. Hardy from R. Farrell, December 1982)
- Life Sciences and Life Support Development Experiments on a Space Station, A.T. Skoog, Dornier System, GmbH, Document No. TN-SSS-DS-005, February 1983

Narrative:

This payload supports experiments concerning human physiological response, behavioral response and clinical technology pertinent to human adaption to space flight. Representative experiments are listed (Table 1); module weights and power are estimated.

Eight discipline groupings (payload, sub-elements) are listed, traceable to data in Ref 1 through 16 as will be described; see Figure 1. Groups 1 to 7 relate to space medical problems, group 8 relates to the development and validation of equipment and procedures to support operational medicine; e.g. altered drug responses, zero-g fluid handling, in flight surgical procedures. Long term human exposure to weightlessness of space heightens the need to obtain useful solutions to medical problems that have been encountered. Among these are: cardiovascular deconditioning, bone mineral loss, loss of lean body mass and muscle strength, decrease in red blood cell mass and nausea associated with space motion sickness. These results and others are described in the SKYLAB report, Ref 1, which summarizes biomedical test results of the last extensive space biomedical study done by the U.S.

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Code: GDCD 0300

PAYLOAD ELEMENT SYNTHESIS

Ref 2 contains a "Comprehensive List of NASA Life Science Concerns" (p I-A-1, therein) without attention to priorities. Similar material in summary form, is listed in Ref 3, 12 and 13. Ref 4 describes NASA's Life Science Program. The graph on page 6-8 therein shows on interpretation of effect of time in space on seven human physiologic changes discovered and/or extrapolated from results of past spaceflight; these seven groups are contained in the synthesis of Ref 1 to 3 and 5-10, which also describe some of the tasks/research for each group (e.g., see Ref 2). Space Station resources requirements for this payload element are derived from Ref 9, 11, and 14. Ref 5 to 10 also describe crew medical problems in space which can be traced to items listed in Ref 2, 12 and 13.

Table 1 Human Biomedical Research

- 1. Human Performance psychomotor neurosensory vestibular
- 2. Bone/Calcium Metabolism
 on-board blood, urine and fecal analyses
 non-invasive bone density tests
 bone biopsy
 mineral analysis
- 4. Cardiovascular/Pulmonary Physiology cardiovascular stressing cardial electrical/mechanical behavior respiratory gas monitoring
- 5. Endocrinology
 Hormonal stress responses
 Fluid/Electrolyte balance

Code: GDCD 0300

PAYLOAD ELEMENT SYNTHESIS

- 6. Hematology/Immunology
 Blood constituents
 lymphatic alterations
- 7. Radiation Effects (interactive with 0301 and Operational Medicine) environment crew radiation monitoring long term medical statistics
- 8. Medical Care Technology
 Zero gravity verification of surgical/orthopedic procedures
 (interactive with 0301)
 Fluid handling
 Pharmacological kinetic

Weight of the Human Research Lab payload is based on 7300 kg, derived from SPACELAB data in Ref 11 and 14 for a similar set of medical experimental equipment (assuming additional onboard analysis instrumentation replacing weight and power requirements of animal holding facilities). SPACELAB payload is 6371 kg (page 121, Ref 11) including a 21% mission managers reserve (914 kg). The 7300 kg value derives from replacing the 21% reserve with a 33% reserve, i.e., (6371-914)(1.33) = 7300 kg. This weight is for experiment equipment and mission peculiar equipment and does not include module weight, the volume however is for the complete module.

Average power requirement of 2000 watts is taken from SPACELAB payload data (Ref 11, p 68). Peak power of 3000 watts (AC) is taken from Ref 11, p 63.

Crew time requirements are derived from Ref 9 (Part II, p 15) aggregating individual operations typical of these types of medical experiments, and using a frequency of measurement based on the NASA Life Sciences hypotheses of Ref 4, p 6-8

40 1, 160 0 0 1 TA 15

PAYLOAD ELEMENT NAME Animal and Plant Research Lab CONTACT W. Hardy/J. Peterson M2 21-9530 General Dynamics Convair Division Addrass P.O. Box 85357 San Diego, CA 92138 Telephone (619) 277-8900, Ext. 3778/2130 STATUS Condidate	0 c 0 0 3 0 1	TYPE X Science L
ACT W. Hardy/J. Peterson M2 21-9530 General Dynamics Convair Division General Dynamics Convair Division P.O. Box 85357 San Diego, CA 92138 Phone (619) 277-8900, Ext. 3778/2130 US Operational Approved	c 0 0 3 0 1	X Science &
ACT M. Hardy/J. Peterson MZ 21-95 General Dynamics Convair Divi General Dynamics Convair Divi General Dynamics Convair Divi General Dynamics Convair Divi General Dynamics Convair Divi Generational Generational		
P.O. Box 85357 San Diego, CA 92138 ne (619) 277-8900, Ext. 3778/2136 perational		Applications (non-commercial)
one (619) 277-8900, Ext. 3778/2130 Operational [Commercial
Operational Approved		<pre>Tachnology Development</pre>
		Operations
Opportunity (10)	5 9	Type Number 4
First flight, yr 1990 No. of flights 1 Duration of Flight, days 3600		(see Table A) Importance of the Space Station to
OBJECTIVE 1) Provide a holding facility for continuous		this Eloment
residency of plants and animals. 2) Provide a research laboratory for experiments in gravitational biology, radiogiology,	rch labora- ogiology,	1 . low calue but Could use
musculoskeletal physiology, cardiovascularphysiology, endocrin- lology neurovestibular physiology, hematology and immunology.	y, endocrin-	10 - vital
to elucidate basic mechanisms of adaptation to spaceflight.	eflight.	Scale 1 - 10 10
DESCRIPTION Pressurized man-operated/man-tended (see special considerations) module containing animal holding facilities for rodents, acquatic species, and primates (5-6 single rack spaces), plant holding facilities (2-3 single rack spaces), laminal flow. Surgical workbench/biological containment facility, 0-1g centriguge and data analysis, and ECS isolated from rest of station. Primate holding facilities will initially accommodate 1-4 primates (e.g., squirrel monkeys to small Rhesus monkey) and at least one double rack will have flexibility to be upgraded to accommodate larger primates. Light, temperature and humidity control is provided. Access to sunlight may be needed.	(see special of species, and properties), lamined data analysis ly accommodate uble rack will crature and hum	considerations) module containates (5-6 single rack of flow. Surgical workbench/s, and ECS isolated from rest l-4 primates (e.g., squirrel have flexibility to be updity control is provided.

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Page 2 of			970		
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			□ Continuous		
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	Tolerance Ephemeris	Field of	no.	Other	
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	Any	Solar sec/sec	U Durat 24 3 Frequency, Hz	ne e d	Digital U bit) D
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	CHA Set Ang	707 70 70 70 70 70 70 70 70 70 70 70 70	3 40	ACCOMMU Ltoring None Encryp Uplink Jon-Boar 128 KE	0 1
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	RB Apo Inc Hod	OOIN OOIN OOIN OOIN OOIN			

CKICINAL 5 POOR n Page 3 of only, with crew activities limited to housekeeping/caretaker roles. Data in this regard is for emphasis and 20 will include the presence of this payload element in its holding facility role primary emphasis - other missions crew time (for task-trainable crew member) is 1 Hr/Day. Size polarization of cytoplasmic constituents. Other plant experiments need q levels of $<10^{-3}$ $<10^{-4}$ includes module accommodation. Minimum g level is for some classes of plant experiments, e.g. SPECIAL CONSIDERATIONS/500 Instructions Of the experiments over 10 years performed Stowed Deployed approximately 20 of these will include the animal and plant research payload as a primary Roturnables, kg H20. 02. Food (Plant/Animal) o min 5×10-5(or 5 -03) 10 5000 Man/Hrs Rog. -0301 Acceleration sensitivity, g min 5×10-5(or Hrs/EUA 0 د X X B E XdE XQE Consummbles, kg Unpressurized 4320 E Man Hours Task Assignment Remote Crew time for service included in routine operations. Dollverables, kg 1111 Pressur 1 zod min -KTH = Consumables Types Amp 90 operational EQUIPMENT PHYSICAL CHARACTERISTICS Extornal non-operational Launch mass, kg operational non-operational Hrs/Day CONFIGURATION CHANGESIInterval, Rouson LEVEL Passive 8 ⊠ SERVICE Interval, days Internal Equipment ID/Function SERVICING/MAINTENANCE Skills (See Table B) Heat Rajoction, w CREU REQUIREMENTS Temperature, deg X Act 1 ve O YES Craw Size Locations

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GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 0301 ELEMENT NAME ANI	MAL AND PLANT RESEARCH LAB
ACCOMODATION: X ATTACHED THEE FLY	ER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATT	ACHMENT AND CHECKOUT)
DATE(S) 1990 INT. HRSEVA	HRS EVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 90 DAYS TOTAL SERVICES 4	0
TMS/OTV REQUIRED	STATION HRS PER SERVICE
☐ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR M	MONITOR, INSPECT, ETC.)
6 HRS PER DAY (INTERNAL)	<u>.</u>
HRS PER DAY (EVA)	
☐ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL 1080 DAYS TOTAL RECONFIGS.	3
TMS/OTV REQUIRED	STATION HRS PER RECONFIG. 16
☐ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	•
DATE(S) INT. HRS. EVA	HRS EVA CREW
▼ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	ABOVE)
 Station OPS Assume time included under static 2 Crewen - 6 hours/day total; termonitor instrumentation, handle sand data analysis. Update equipment for larger specified. Payload continues operation after 	nd animal and plant, specimens, biochemical imens.

TOTAL EVA HRS 0

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Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 0301

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Animal & Plant Research Lab

Reference Documents:

- Life Sciences Considerations for Space Station, Life Sciences Division (EB-3), Office of Space Science and Applications NASA, Washington, DC 20546. September 14, 1982.
- 2. Report of the Study Panel for Plant Biology in Space Exploration, R.W. Krauss, Chairman, American Institute of Biological Sciences, June 24-25, 1978
- 3. Letter from R.W. Krauss, Executive Director, Federation of American Societies for Experimental Biology, to Dr. G.A. Soffen, NASA. Subject: Report of Committee Considering the Problems in Understanding the Effects of the Space Environment on Higher Plant Growth, July 6, 1982
- Man Tended Life Sciences Research Facility: A Conceptual Design and Analysis Study; NASA Marshall Space Flight Center, January 1982
- 5. Spacelab Mission 4, Mission Definition Study Report Summary; Study Manager, M.J. Harnage, Jr., Johnson Space Center, November 1982
- Final Reports of U.S. Experiments Flown on the Soviet Satellite Cosmos 782, edited by S.M. Rosenzweig and K.A. Souza, Ames Research Center, September 1978
- 7. Final Reports of U.S. Experiments Flown on the Soviet Satellite Cosmos 936, edited by S.M. Rosenzweig and K.A. Souza, Ames Research Center, September 1978
- Life Sciences Research and the Science and Applications Space Platform, E.W. Gomersall, Coordinator, Biosystems Division, Ames Research Center, February 1982
- 9. Life Sciences Experiments for a Space Platform/Station; J.D. Fabricant, University of Texas, Medical Branch, Galveston Texas; Society of Automotive Engineers Technical Paper 820834, Twelfth Intersociety Conference on Environmental Systems, Sam Diego, July 1982
- Life Sciences Mission Requirements Document (Draft) edited at Ames Research Center, November 1982
- Life Sciences Laboratory Equipment (LSLE) Handbook, Johnson Space Center, 1981

A 40 1995 15

Code: GDCD 0301

PAYLOAD ELEMENT SYNTHESIS

- 12. Space Station User Fact Sheets and Contact Reports (attachments to letter to W. Hardy from R. Farrell, December 1982)
- 13. Life Sciences and Life Support Development Experiments on a Space Station, A.I. Skoog, Dornier System, GmbH, Document No. TN-SSS-DS-005, February 1983

Narrative:

This payload will enable the investigation of plants and animals living in a microgravity environment over their entire life cycle. The animal studies will include experiments for validating animal models of human physiology and experiments to elucidate basic mechanism of adaptation to microgravity (Ref 1, p 13, Ref 8 and 9). Plant research will include 14 areas of study of basic mechanisms (Ref 2 and 3) as well as applied research in support of future operational CELSS.

Facilities will be needed to hold live specimens including rodents, primates, aquatic species, higher plants and simple plants, microbial species, and tissue cultures. Facilities will also be needed for manipulation of the speciman and containment of all fluids and particulars associated with these manipulations (e.g., mass measurement, surgical procedures, drawing blood, biochemical analyses of plant/animal tissues, and specimen preservation and storage). A laminar air flow/glove-box type design is envisioned, such as the Spacelab-4 General Purpose Work Station. A centrifuge will be needed to provide various g levels from C.lg to 1.25g for a subset of the plant and animal population.

The specimen demands for the full range of research described in Ref 2, 3, 8, 9, and 10 would, if performed on the same mission, exceed the capabilties of the module recommended by Convair. However, a research program could be time-phased so that six single-rack-sized animal holding facilities and three single rack-sized plant holding facilities could accommodate a continuing Spacelab-4 design, and a representative experiment program would include 72 mice and 60 rats, and using a new design, three small rhesus monkeys. In the later years, new hardware would be needed to support the inclusion of larger primates in the payload.

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Code: GDCD 0301

PAYLOAD ELEMENT SYNTHESIS

Data in Ref 4 is taken for estimating payload weight, size and power required. From page 112 of Ref 4 (Spacelab long module #3A) payload weight is derived at 9520 lb (4320 kg), obtained from sum weight of ECLS (1762 lb), Equipment (1744 lb), assorted other items (1908 lb), expendables (3328 lb) and 25% contingency of (1762 + 1744). Module and associated equipment weight are not included in payload weight).

An operating power of 2kW is taken for this payload based on data in Ref 5. standby and peak powers of 1 and 4 kW, respectively, are judgemental values. Data transmission rates are taken from Ref 5. Ref 5 is used for power and data rates (vs Ref 4). The volume of 7 by 3.4 by 3.4 = 81.0m 3 approximates the volume of module 3A in Ref 4 (p 156), namely; 2808 cu. ft/35.3 = 79.5 m 3 .

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		Page 1 of 3
PAYLOAD ELEMENT NAME	CODE	ТУРЕ
EVA Performance and Productivity	G D C D O 3 2 2	X 8046108 X
		Applications (non-commercial)
Mudrass P.O. Box 85357 San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Technology Development
STATUS		
Operational NP lanned	ned	U0perations
	Opportunity	
First flight, yr 1990		(see Table A)
No. of flights 1 Duration of Flight, days 3600		Importance of the Space Station to
		this Element
Monitor EVA physiological workload in relation to performance of broad spectrum of generic EVA tasks, and use to plan task loading, new tools, procedures, training and suit modifications.		1 = low value but could use 10 = vital
		Scale 1 - 10 10
DESCRIPTION During EVA, while parforming many "typical" tasks, metabolic rate will be monitored based on measurement of heart rate, 02 consumption/CO2 production, core temperature and	many "typical" tasks, consumption/CO2 produ	metabolic rate will be moni- ction, core temperature and
thermal load or body heat rejection required. Simultaneously, suited body motions will be monitored via film or video tape and subject to time and motion analysis. These physiological and the subject to time and motion analysis. These physiological and the subject to time and motion analysis.	Simultaneously, sui to time and motion an	ted body motions will be alysis. These physiological
and pnychophysical data will be combined with physical measurements (e.g., force, toque) and subjective judgements of the crew performing the tasks, and used to evaluate new tools, procedures, suit modifications in order to plan crew workload. Equipment is double rack mounted,	the tasks, and used the workload. Equipme	o evaluate new tools, procer nt is double rack mounted,
including video monitor, biomedical data display, microcomputer, movie camera, stowage for tools, mobility devices and force measurements instruments. Reference GDCD 2402 for description of equipment.	olay, microcomputer, m s instruments. Refere	ovie camera, stowage for nce GDCD 2402 for description
	والمتالية والمتا	

•						- 7			Γ	
2 Page 3 of		Stowed Deployed				750		kg 4		
CODE	X X 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	Surizo H, m H, m ₂₇		7	0.25	ions Hrs/EUA	03,	Man/Hrs Red. Returnables.	V / L	Offe Crew member 15 EVA.
	Passive operational min non-operational min operational min non-operational min	S E E E		SKILL 2		Rousson Routine Opeations		Interval, day 720 Deliverables, kg	ctions	ncluded in routine operations. O
	THERMAL Active Passive Temperature, deg C oper Non-oper Heat Rejection, w oper	EQUIPMENT PHYSICAL CHARACTERIST Location X Internal Exterior Exterior Presequipment ID/Function 1.5 L,m 1.5 L,m CREU REQUIREMENTS 2	Skills (See Table B)		TO X YES	SERUICING/MAINTENANCE 90 SERUICE: Interval, days	CONFIGURATION CHANGES:Int.	SPECIAL CONSIDERATIONS/500	crew time for service included	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 0322 ELEMENT NAME EVA	PERFORMANCE AND PRODUCTIVITY				
ACCOMODATION: X ATTACHED TREE FLY	ER OTV OPS				
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	ACHMENT AND CHECKOUT)				
DATE(S) 1990 INT. HRS EVA	HRSEVA CREW				
NOT APPLICABLE					
2. SERVICE (E.G., REPLENISH/RESUPPLY)					
INTERVAL 90 DAYS TOTAL SERVICES 40					
TMS/OTV REQUIRED	STATION HRS PER SERVICE				
□ NOT APPLICABLE EVA HRS PER SERVICE					
	EVA CREW SIZE				
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR N	IONITOR, INSPECT, ETC.)				
.25 HRS PER DAY (INTERNAL)					
.25 HRS PER DAY (EVA)					
☐ NOT APPLICABLE	•				
4. RECONFIGURATION					
INTERVAL 720 DAYS TOTAL RECONFIGS.	5				
TMS/OTV REQUIRED	STATION HRS PER RECONFIG. 4				
☐ NOT APPLICABLE	EVA HRS PER RECONFIG.				
	EVA CREW SIZE				
5. DEACTIVATION/REMOVAL	•				
DATE(S) INT. HRS. EVA	ADC CVA CDEW				
	EVA CAEN				
NOT APPLICABLE					
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	ABOVE)				
 Video tapes, etc. crew time incl 1 crewman is for EVA routine oper 	uded under Station OPS rations associated with experiment				
 Change equipment Payload continues operation after 	•				
J. rayivad continues operation after	2000				

Page 1 of 1 Volume II, Book 1 Appendix I

Code: GDCD 0322

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: EVA Performance & Productivity

Reference Documents:

1. SPACELAB Payload Accommodation Handbook SLP/2104. Issue No. 1, Revision No. 5. January 31, 1981

Narrative:

Many EVA tasks will be required for the Space Station. A new (hard) suit is planned as well as new tools. To assure that such tasks are done safely and efficiently, with best use made of the new equipment, goals will need to be developed for human performance and productivity. Training methods need to be devised. This Payload encompasses these aspects. Double racks are planned to house equipment and tools. Data in Ref 1 is taken for rack size, weight, and data transmission rates.

	Page 1 of 3
PAYLOAD ELEMENT NAME H>0/0>/CO>/N> Regenerative Syst	,
356	X Science &
W. Hardy/J. Peterson MZ 21-9530	Applications
**	(NOT - COMMON TO)
Can Diona CA 02130	
301 Diego, CA 32130	
T-1	Technology
	Devalopment
Operational XPlanned	Operations
U Opportunity	Type Number
First flight, yr 1991	(see Table A)
3650	
The state of the s	this Flosont
ife rs	1 = low value but nould use
	10 - oital
periods with minimum resupply.	
	Scale 1 - 10 10
DESCRIPTION	
Stand-alone and rack-mounted ECLS components/subsystems to verify zero-g operation of physical	zero-g operation of physical
and chemical processes for H2O reclamation, O2 generation, CO2 rem	oval/reduction, and N2 gen-
4	osphere and water. Goal is
.to incegrate verilled components with space station operational systems.	stems.

ORIGINAL PAGE 19 OF POOR QUALITY

n		01 10	OR QUALITY		
3 4 0 Page 2 of	† 111		Continuous	Fraquancy (MHZ)	1 MHZ)
CODE 6 0 C D O 3 4 O	RISTICS NV Periges, km Any Tolera log Any Tolerance + log Ephemeris Ac	POINTING/ORIENTATION Usew direction Inertial Solar Earth Truth Sites (If known) Pointing accuracy, arc sec	Restric AC erating andby	MUNICATIONS ng requirements: Realtime Offline Other yption/Decryption Required nk Req.: Command Rate (KBS) oard Data Processing Required ription toring of Process Variables, 8 KBPS for 1 Hr/Day	

ORIGINAL PAGE 13 OF POOR QUALITY

CODE G. C. D. O. 3.4.0 Page 3 of 3
g C operational min non-operational min 50
Remote
L, m 1.8 U, m
1280 12/Spares
IREMENTS
LEVEL 2 3 Hrs/Day 0.5 0.5
AMINTENANCE Corval, days Consumables,
Man Hours
Picokhilon Chances Interval, day 220 nandris Koq. Deliverables, kq
ve to Sun/no Sun operatic Id be removable/replaceab
alternate interface possibilities relative to available space for connecting power and fluid

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDC	D CODE	0340		ELE	MENT NAME	H ₂ 0/C0	2/02/N2	REGENERATIV	'E SYSTEMS
					☐ FRE				
1. S	TATION .	ACTIVAT	10N (E.	G., SET-U	P/ASSEMBLY	//ATTACHI	MENT AND	CHECKOUT)	
0	ATE(S)_	1991	IN	T. HRS _	24	EVA HRS		EVA CREW	<u></u>
	_			-					
	☐ NOT	APPLICA	ABLE						
2. S	ERVICE	(E.G., REI	PLENISH	1/RESUP	PLY)				
11	NTERVA	L	DAYŞ	TOT	AL SERVICE	s			
	☐ TMS	VOTV RE	QUIRED			ST	TATION HRS	PER SERVICE _	···
	⊠ NOT	APPLICA	BLE			£,	VA HRS PER	SERVICE _	
						£'	VA CREW SI	ZE	
3. S	TATION	OPERATI	ONAL S	SUPPORT	(AVG. TIME	FOR MONI	TOR, INSPE	CT, ETC.)	
		HRS PE					·		
		HRS PE	R DAY (EVA)					
		APPLICA							
		GURATIO							
!!	_		<u>-</u> '		TAL RECON				6 l 12
		OTV RE				ST	ATION HRS	PER RECONFIG	0 4 40
	☐ NOT	APPLICA	BLE			EV	A HRS PER	RECONFIG	
						EV	A CREW SIZ	.E	
5. 0	EACTIV	AT' ON/RI	EMOVA	L					
0	ATE(S)_		IN	T. HRS		EVA HRS		EVA CREW	
	_			_					
	⊠ NOT	APPLICA	BLE						
6. N	OTES (B	RIEFLY (ESCRIE	E TASKS	S IN 1 THROU	JGH 5 ABO	VE)		
1.		_							
3.	Equi	pment	opera	tion	setup tir				
4.	Reco	nfigur	ation	: Ini	tially 19	993 at (6 hours;	two years	later
5.					imes.	total =	108 m h	onfiguration ours	n 48 nours

TOTAL EVA HRS 0

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Code: GDCD 0340

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: H₂O/CO₂/O₂/N₂ Regenerative System

Reference Documents:

1. Extended Mission Life Support Systems by P.O. Quattrone, NASA AMES Research Center, June 1981.

- 2. Space Station Technology Readiness by R.F. Carlisle and J.H. Romero. ASME National Meeting, Phoenix, Arizona. November 1982.
- 3. Space Station Technology by P.T. Holloway. NASA LRC presented at the 33rd International Astronautical Federation Congress, Paris, France, 1982
- 4. Space Station Environmental Control and Life Support System, Preliminary Conceptual Design by C.H. Lin. NASA JSC. Doc. No CSD-SS-059, JSC-17727, September 1982.
- 5. A Regenerative Life Support System for Space Operations Center (SOC). A probable First Flight application by H.F. Bros (Ham. Std.) ASME Paper 81-ENAs-12, 1981
- 6. Life Sciences Considerations for Space Station, Life Sciences Division (EB-3) Office of Space Science and Applications; NASA, Washington, D.C. 20546, Sept. 14, 1982.
- 7. Space Station Needs, Attributes and Architectural Options Contractor Orientation Meetings. Preliminary Agenda. Life Sciences Section by Dr. W. Bishop. Sept. 1982.

Narrative:

Life support of a space crew on an extended stay mission requires consideration of supply logistics for items such as cabin air, water, and removal of atmosphere contaminants like CO2. The tack chosen here for this payload is research/development/integration experiments to obtain an operational closed type regenerative life support system by 1996. Time phasing is based initially on a system sized for a crew of two with sequential 90-day tests and modifications for a period of six years starting in 1991. After 1994, the system will be sealed-up to support a crew of eight operationally by 1996. Support for 8 people is assumed in Ref 1-5, including prior work.

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Code: GDCD 0340 PAYLOAD ELEMENT SYNTHESIS

By 1992, the system will recover potable water from humidity, waste water, and remove $\rm CO_2$ from the atmosphere; this is t partially closed system to which reference will be made later with Figure 1. By 1994, further development will obtain additional closure, producing $\rm O_2$ by electrolysis of reclaimed water, $\rm N_2$ from hydrazine dissociation and reducing $\rm CO_2$ to produce additional water; this is the additionally closed system. The foregoing 1990-1996 components of the regenerative systems are found in Ref 1 to 7; the 1991-1996 time phasing is Convair's judgement.

A 10-year completion time phasing for the regenerative system is projected in Ref 1, p 16, including in-flight demonstrations and system/subsystem/component developments. Using this 10-year period, the Convair 1996 projected operational date would require about 1986 as a work start date. An operational system is taken to include redundancies, fail safe/operational etc., which need not be fully included in years prior to 1994, while experiments are in progress. Two rejenerative units, each supporting four persons can also be considered.

Table 1 summarizes weight, volume and power for the 1991 launch, 1992 and 1994 updates, warrived from the literature. Figure 1 taken from Ref 1 shows launch weights versus person days in space for an open loop and varying amounts of loop closure; the use of Figure 1 to obtain Table 1 will also be described.

The life support system is considered as "open loop" if much consumable resupply is needed. H₂O especially is a costly resupply payload item. Life support consumables can be regenerated on-board. Figure 1 predicts considerable launch weight reduction only by regenerating H₂O and removing CO₂; additional launch weight reduction is predicted with O₂ generation by electrolysis of water and CO₂ reduction to produce more water.

As example, Figure 1 shows with CO_2 removal, about 7700 pounds launch weight for 8 x 90 = 720 person days; the weight doubles if allowance is made for a 90-day contingency according to Ref 2, p 11. With decreasing mission duration, Figure 1 predicts more launch weight with increasing loop closure.

Ref 2 (p 11) and Ref 3 (r 11) suggest that the partially closed-loop system be included in the initial bace Station module. Whether the system will be operational by 1991 is but certain and seems to depend on the proof testing that can be done by the late 1980s. Ref 6, p 28 indicates the initial Space Station will use more consumables than required by the regenerative system and suggests that technology module packages be added-on to achieve an evolutionary regenerative capability; existing life support systems (open loop) would remain functional as a back-up, causing the early years consumable increase.

Code: GDCD 0340

PAYLOAD ELEMENT SYNTHESIS

Table 1. Regenerative Life Support Time Phasing

				WEI	3HT ⁰	VO	LUME		POWER, KV	v
EXPERIMENT	YEAR	CREW No.	MISSION DAYS	KG	LB	M3	(FT. ³)	SUNLIT (58 MIN)	ECLIPSED* (38 MIN)	AVERAGE**
I	1990-92 INCLUDES CO ₂ RE- MOVAL IN	2	90	1280	2820	6	218	4.2	2.4	3.5
11	FIG 1 1992-94 INCLUDES CO ₂ RE- DUCTION IN FIG 1	2	90	2064	4550	12	423	4.2	2.4	3.5
Ш	1994-96 SCALE-UP OF II***	8	90	5515	12,379	27	959	16.8	9.5	13.9

266.592-456-1

^{*} ON BATTERY POWER

** KW, AVERAGE = [(SUNLIT KW) (58) + (ECLIPSE) (38)]/96

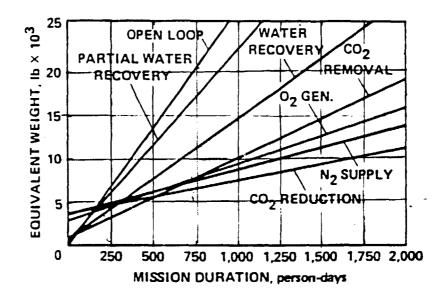
*** OPERATIONAL AFTER 1996

O DOES NOT INCLUDE POWER-WEIGHT PENALTY, TBD

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Code: GDCD 0340 PAYLOAD ELEMENT SYNTHESIS



SEQUENTIAL STEPS IN LOOP CLOSURE

DEFINITION	DESCRIPTION
PARTIAL WATER RECOVERS	HUMIDITY CONDENSATE COLLECTION
WATER RECOVERY	POTABLE WATER RECOVERY AND TREATMENT FROM URINE AND WASH WATER
CO ₂ REMOVAL (NONEXPENDABLE)	REPLACEMENT OF EXPENDABLE LIGH WITH REGENERATIVE CO ₂ COLLECTION TECHNIQUE
O ₂ GENERATION	GENERATION OF ${\rm O_2}$ THROUGH WATER ELECTROLYSIS USING RECLAIMED WATER
N ₂ GENERATION	GENERATION OF N ₂ THROUGH DISSOCIATION OF HYDRAZINE*
CO2 REDUCTION	OECREASE IN EXPENDABLE WATER BY RECOVERING PRODUCT FROM CO ₂ REDUCTION (SABATIER) PROCESS
Approximating Equations	for Figure **
Open loop Water recovery CO ₂ removal O ₂ generation CO ₂ reduction	weight = 27.2 (PD), 1b weight = 13.5 (PD) + 1250, 1b weight = 9 (PD) + 1200, 1b weight = 6.5 (PD) + 3050, 1b weight = 3.75(PD) + 3875, 1b

assuming hydrazine is available, say, for thruster control

266.592-451

Figure 1. Regenerative vs Open Loop EC/LSS

^{**} PD = person days

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Code: GDCD 0340 PAYLOAD ELEMENT SYNTHESIS

The status of regenerative technology is discussed in Ref 5, p 8, noting that such technology is defined currently either from space tests or laboratory work. However, Ref 5, p 8, refers to the need for continued research and development to accomplishing the following: optimize equipment, require less crew monitoring, improve maintainability, increase system life, decrease weight and reduce power consumption.

These remarks imply a need for further development; a prototype regenerative system might be available for a 1990 launch if pertinent component tests are made before 1990 of a complete unit. In view of this current implied status, Table 1 denotes a 1991 launch of a partial regenerative unit for a crew of 2 and requiring in-orbit experiments for futher development. The 1992 launch also for a crew of 2 is shown in Table 1 as an update to include additional regenerative closure. Finally, the 1994 launch will be an updated 1992 system, but sized for a crew of 8 - and developed until operational in 1996.

Weight, volume, and power in Table 1 are estimated from data in Ref 1 and 5 as follows:

EXPERIMENT 1 (Table 1)

- 1. A 1991 launch weight of 2820 lb (1280 kg) is obtained from the Figure 1 water recovery line and is based on a crew of 3 for a 90-day mission (180-person days). This weight includes recovery of potable water from humidity, waste water and CO₂ removal from the atmosphere. There is no contingency supply in Figure 1.
- 2. System volume for the above weight can be estimated from data in Ref 6, p 7 showing 12, 379 lb, weight and a 959 ft³ volume. These values yield 12, 379/959 = 12.9 lb/ft³. Applying this density to the previous 2,820-lb weight leads to $2820/12.9 = 219 \text{ ft}^3$ (6 m³). Intuitively, the expection is for a volume to decrease slower than the weight ratio. However, the 12, 379 pounds in Ref 5 includes more features than the 2820-1b. system, such as CO_2 reduction of N_2 , O_2 , etc. Consequently, the 6 m³ value will be taken.
- 3. System power for the 2820 lb system (item 1) is estimated at 4.2 kW during the sunlit part of the orbit and 2.4 when eclipsed (batteries required). These power values are based on Ref 6 data (12,379 lb system) of 16.8kW (sunlit, 58 minutes) and 9.5 kW (eclipsed, 38 minutes), reduced by the crew ratio 2/8; intuitively, the powering for air/water flow rates would seem dependent on crew number. Average power for a 96-minute orbit is estimated from (4.2 kW x 58 min. + 2.4 kW x 38 min.)/96 min. = 3.5 kW. Similarly, an average 13.9 kW value can be calculated for the 12, 379-1b system in Ref 6; for comparison Ref 4, p 4 lists a 21-day, 10-kW emergency electrical power for crew survival.

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PAYLOAD ELEMENT SYNTHESIS

Similarly, for the 1992-1994 period, the following weight, volume, power is noted.

EXPERIMENT II (Table 1)

- 1. System weight in 1992 is estimated at 4550 lb (2064 kg) due to additional modules for further loop closure with 02, N2 generation, and CO2 reduction. This weight is based on 180 person days in Figure 1. The weight increase 4550-2820 pounds above the Experiment I weight is inherent to the trade-off data in Figure 1 with decreasing person days.
- 2. Corresponding system volume is estimated at 423 ft 3 (12 m 3) and obtained from (4550/12.9) x (1.2) = 423 ft 3 . This result is for a reduced scale of the system in Ref 5 p 7; the 1.2 factor is a judgement that volume may not decrease directly with weight for the scaled down version.
- 3. System power is estimated 16.8 x 2/8 = 4.2 kW (sunlit) and 9.5 x 2/8 = 2.4 kW (eclipsed) assuming, as before, that power is proportional to the crew number, data in Ref 5, pp 7 and 8. Average power, similarly is 3.5 kW.

The operational system in 1996 for 8 persons is a scale-up from the 2 person experimental system of 1992-1994; weight volume, power of the 8 person system follow next.

EXPERIMENT III (Table 1)

- 1. Weight is 12, 379 lb (5515 kg) for a crew of 8 on a 90-day mission, taken directly from Ref 5, p 7. This weight is about twice the value obtained from Figure 1 for the CO₂ reduction line at 720 person days. The weight difference is due mostly to the additional functions in Ref 5 that are not believed to be included in Figure 1; namely, cabin ventilation and thermal control, heat transport and rejection; health and hygiene, EVA/IVA support and spares.
- 2. Corresponding volume is 959 ft^3 (27 m^3), taken directly from Ref 5.
- 3. Corresponding power taken from Ref 5 is 16.8 kW (58 min. sunlit), 9.5 kW (38 min. eclipse) and 13.9 kW average.

			Page 1 of 3
PAYLOAD ELEMENT NA CELSS Experimental Syst	. NAME Systems	CODE 6 D C D O 3 4 1	
CONTACT W. Hardy/J. Pe Namo General Dynami Addross P. Roy 85357	W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division P.O. Roy 86367		Applications (non-commercial)
San Diego,	CA 92138		- Commercial
Telephone (619) 277-8900, Ext.	900, Ext. 3778/2130		Technology
STATUS Operational	Z Z		
Approved	Candidate	Candidate Opportunity	Tube Number
ght, gr lghts of Flight	21		
OBJECTIVE Develop, verify and int	OBJECTIVE Develop, verify and integrate components of a space station life	space station life	this Eloment 1 - low value but
support system which migen and processes organ	support system which minimizes resupply of food, water and oxy- gen and processes organic wastes for maximum reuse.	ood, water and oxy- reuse.	could use 10 - vital
			Scale 1 - 10 10
DESCRIPTION Stand-al zation (e.g., wet oxide higher plants (e.g., le (e.g., le).	lone equipment for wast ation waste processor) ettuce, tomatoes, carrc sts. There will be pro	ce recycling, water re plant growth chambers its, wheat, soybeans, itotype control instru	ESCRIPTION Stand-alone equipment for waste recycling, water recovery, atmospheric revitalization (e.g., wet oxidation waste processor) plant growth chambers with species of edible higher plants (e.g., lettuce, tomatoes, carrots, wheat, soybeans, peanuts), algae cultures (e.g., spirulina), yeasts. There will be prototype control instrumentation such as flow meters
and nutrient concentral g. Trial of candidate i different "day/night" o plants, and trade-offs	ation monitors. Verification is required of component operation integration scenarios including artificial vs sunlight plant irricycles, different plant species and percentage of crew diet supp s to optimize the system. Reference GDCD 1303 for commercial use	cation is required of ncluding artificial versecies and percental. Reference GDCD 13C	and nutrient concentration monitors. Verification is required of component operation in zero-g. Trial of candidate integration scenarios including artificial vs sunlight plant irradiance, different plant species and percentage of crew diet supplied by plants, and trade-offs to optimize the system. Reference GDCD 1303 for commercial use.

e		ORIG	MAL PAGE 18 OOR QUALITY		, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
C. D 0 3 4 1		58	Continuous	Frequency (MHZ)	, (MHZ)
3 (0 ° 9)	ORBIT CHARACTERISTICS Apogoe, km Any Perigee, km Any Tolorance + Inclination, deg Any Tolorance + Nodal Angle, deg Escape du Reguired, m/s	ENTATION On DI (If known uracy, arc	3	MMUNICATIONS Ing requirements: Caltime Offline Other ryption/Decryption Required Ink Req.: Command Rate (KBS) Soard Data Processing Required	Data Types: Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

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(OF PO	OR QUALITY	
3 4 1 Page 3 of	<u> </u>	Stowed Deployed	5 3 4 4/Hrs Req. Lurnables, kg hotosynthesis experiment , respectively. May need to s (GDCD 0340). Updates in and 10,500/111/17.5, respec-	
CODE 6 0 C 0 0 3 4 1	20 30 30 40 40 40 40 40 40 40 40 40 40 40 40 40	3	gnment	
		CHARACTERISTICS nal External lon Spressurized L,m 3 U,m L,m 3 U,m Launch mass, kg Consumables Types Acceleration sensit	FEMENTS Task Assignment Table B) EVEL Hrs/Day O.5 Consumables, kg turnables, kg NSIDERATIONS/Soe Instructions of 8 and 48 hours, respectively. Yeast). Two types of reconfiguration of 8 and 48 hours, respectively. With mass, volume and power increasing to 5250/56/8.8 and 10,500/111/jumables are 275 kg (1994-1996) and 550 kg (1996-1998). Cross training	
	THERMAL MActive Temperature, deg Heat Rejection, v	EQUIPMENT PHYSICAL Location; XInter Equipment ID/Funct	Size Size Size Size Size Size Size Size	skills.

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

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GDCD CODE 0341 ELEMENT NAME CEL	SS EXPERIMENTAL SYSTEMS
ACCOMODATION: X ATTACHED TREE FLY	ER 🔲 OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	ACHMENT AND CHECKOUT)
DATE(S) 1992 INT. HRS 24 EVA	HRSEVA CREW

☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 90 DAYS TOTAL SERVICES 24	<u> </u>
TMS/OTV REQUIRED	STATION HRS PER SERVICE
NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR M	IONITOR, INSPECT, ETC.)
2.0 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
☐ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL 720 DAYS TOTAL RECONFIGS.	
☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIG. 8 & 48
☐ NOT APPLICABLE	EVA HRS PER RECONFIG.
·	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	•
DATE(S) 1998 INT. HRS EVA H	RS EVA CREW
NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	ABOVE)
1. Experiment peculiar setup time	
 Plant nutrients, consumables. Cr Equipment tests 	ew time assumed as part of routine ops.
4. Initial reconfiguration needs 8 m	an hours; 2nd reconfiguration
is a major reconfiguration and re	quires 48 man nours.

Page 1 of 4 Volume II, Book 1 Appendix I

Code: GDCD 0341

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: CELSS Experimental Systems

Reference Documents:

- NASA Information Bulletin on CELSS. Ames Research Center. 10/82
- 2. Foundations of Space Biology and Medicine. Volume III, Space Medicine and Biotechnology, Chapter 10. Biological Life Support Systems, Washington, D.C. 1975.
- 3. Life Science and the Science and Applications Space Platform by E.W. Gomersall, Ames Research Center January 1982.
- 4. Controlled Ecological Life Support Systems (CELSS) Program Plan. NASA EBT-3/Chief, Biological Systems Research. March 1982.
- 5. Life Sciences considerations or Space Station, Life Sciences Division (EB-3). Office of Space Science and Application; NASA, Washington, D.C. 20541. September 14, 1982.
- 6. Controlled Ecological Life Support System: Transportation Analysis by E. Gustan, T. Vinopal. NASA Contractor Report 166420 by Boeing Aerospace Co. for ARC. November 1982.
- 7. Controlled Ecological Life Support System. First Principal Investigators Meeting. Edited by B. Moore, III, R. A. Wharton, Jr. and R. D. MacElroy. NASA Conference Publication 2247. Published 1982.
- 8. CELSS Principal Investigators Conference. Abstracts. December 6-8.

Narrative:

A Controlled Ecologica: Life Support System (CELSS) has the potential to provide food and environmental control with energy input and a minimum of resupply. CELSS is a closed-loop type system, requiring equipment to recycle water, air, waste (human, plant), monitor water/air, grow food, and store supplies produced; see Ref 1. Estimates are given for CELSS weight, volume and power, starting from a 1992 launch with upgrades until operational in 1996.

Fundamental CELSS background aspects are described, for example, in Ref 2 on plant growth, waste utilization, experimental systems and mathematical modeling. From Ref 2, the basic CELSS operations are seen to be: water reclamation, air revitalization, waste management, food growing; these items are combined in Ref 3 to denote three major CELSS research areas; namely, waste management, food production, and system control.

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Code: GDCD 0341 PAYLOAD ELEMENT SYNTHESIS

Time phasing for the above CELSS development, design, and test is given in Ref 4, p. 43, showing: by 1985 definition of food to be grown, and subsystem waste management; by 1987 selection of optimal system approach, by 1990 start of experiments. With experiments starting in 1990, Ref 3 suggests that CELSS may be able to supplement Space Station food supply by the mid 1990's (page 12, Program Plan); this ability includes H₂O and O₂ generation, implicit to the CELSS concept.

A CELSS equipment build-up for experiments, in modular form is anticipated after 1992; some CELSS equipment is similar to that for regenerative life support experiments in GDCD 0340. This similarity is noted in Ref 5, p 29, offering the possibility for equipment sharing during the development of both systems and when both are operational.

Ref 6 considers a complete CELSS food growing installation (4 men) and trade-offs with an equivalent 100% resupply system. Conventional type vegetables are assumed for the Ref 6 CELSS study. Other food types are being considered in NASA's programs, such as yeast and algae; see Ref 7 and 8.

An estimate of the CELSS characteristics will be made using data in Ref 6; there, the 1990 CELSS launch weight is given for 0, 50, and 97% food closures based on growing conventional food-vegetables for a crew of 4 - in all three cases, water/air closure is 100%. The 1990 CELSS launch availability requires continuous development starting from the mid-1980s, as noted.

Convair's projected time phasing for CELSS is listed in Table 1; assumptions made are: CELSS will be operational in 1998 (versus 1990 in Ref 6), feeds 4 persons with 50% food closure and 100% water/air closure. Reasons for selecting this 50% value are:

- Less launch weight after 1996 vs 0% food closure, compared with a 1998 breakeven data for 97% food closure; see Ref 6, p 83 (a 0% food closure requires 100% food resupply).
- 2. A \$20,000,000 lower cumulative cost estimate (at this stage of development) between the 1996 (50%) and 1998 (97%) dates for item 1 see Ref 6. p 100.
- 3. A 50% vegetarian diet may be acceptable to a non-vegetarian crew person (or one not preconditioned to eat mostly vegetables.

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Code: GDCD 0341

PAYLOAD ELEMENT SYNTHESIS

Table 1. CELSS Time Phasing Experiments*
(50% Food Closure/Person, 100% water/air closure/person)

			CELSS	WE:	IGHT ^O	VOI	LUME(a)	201122	CONSUM-
ITEM	YEAR	TASK	CREW SIZING	kg	16	_M 3	FT3	POWER kw	ABLES, kg oo
1	1992- 1994	EXPERI- MENTAL	1	2625 (7560)	5790 (16,700)	28	980	4.4	138
2	1994- 1996	EXPERI- MENTAL	2	5250 (10,190)	11,600 (22,500)	56	1960	8.8	275
3	1996- 1998	EXPERI- MENTAL	4	10,500 (15,500)	(23,200) (34,400)	111	3920	17.5	550
4	1998	OPERA- TIONAL	4	10,500 (15,500)	23,200 34,100	111	3920	17.5	550

^{*} Based on data in Ref 6, p 76 showing 10,500 kg CELSS weight for a crew of

oo Consumables = 550/crew where 550 is Ref 6 value for four persons (p 76)

Table 1 assumes CELSS weight, volume and power vary directly with crew size being fed by CELSS; the nominal CELSS weight is 10,500 kg (4 people) given in Ref 6, p 76.

The study of Ref 6 locates CELSS equipment in a pressurized module of 4888 kg weight and lll m^3 volume. Ref 6 also uses a resupply module, weight 47 kg, 1.7 m^3 volume (p $7\tilde{v}$). Mission data set sheets do not include the weights and volume of a CELSS and resupply module.

CELSS food growing components are listed in Ref 6, p 58; included in the listing are a plant growth area of 14 m 2 /person and 150 watts/m 2 illumination power for 4 persons .38 watts/person); these values are based on 50% food closure/4 persons.

Additional background data on NASA's funded CELSS program are found in Ref 7 and 8.

^{** 10,500/4}

Numbers in parenthesis include CELSS module weight of 4888 kg plus 47 kg (resupply module with volume 1.7 m³); see Ref 6, pp 70 and 76.

⁽a) Does not include 1.7 m³ volume of resupply module, Ref 6 p 76.

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PAYLOAD ELEMENT SYNTHESIS

Though Table 1 is based on conventional vegetable type food, Ref 4, p 38 includes algae, bacteria, yeast, and chemical synthesis as food to be evaluated. These food types need consideration of toxicity to humans relative to environmental interaction, Ref 6, p 39.

Perhaps one other food type besides the conventional vegetables can be CELSS evaluated in space between 1990-1992; equipment commonality will be needed for the two food types and a decision made by 1992. If not, the food choice by 1988 seems needed if CELSS is to be space operational by 1998. The subject needs early attention relative to CELSSs.

Regarding early year CELSSs activities, Ref 5, p 29 foresees the following experiments:

- Evaluating equipment performance (similar to regenerative life support systems)
- Biological processes in weightlessness
- Biological systems interacting with the spacecraft environment during first three years

A final point concerns continuing experimentation with algae, yeast, etc. well into the 1990s. The CELSS pallet concept GDCD 0343 supports this possibility in conjunction with GDCD 0301 - the Animal and Plant Research Laboratory.

ORIGINAL PAGE 19 OF POOR QUALITY

	Page 1 of 3
PAYLOAD ELEMENT NAME Dedicated CELSS Module	•
Peterson KZ 21-9530 namics Convair Division	Applications (non-commercial)
San Diego, CA 92138	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Tachnology Development
שר	Operations
☐Approved ☐Candidate ☐Opportunity	Type Number 4
First flight, yr 1996 No. of flights 1 Duration of Flight, days 1460 OBJECTIVE	(see Table A) Importance of the Space Station to this Element
Produce food, revitalize atmosphere, recover water and process/ recycle organic solid and liquid waste late 1990's objective include growth of 50% of crew food, 100% of water from reclama-	1 - low value but could use 10 - vital
	Scale 1 - 10 10.
DESCRIPTION CELLS is a man-tended system for growing food (e.g., lettuce, tomato, wheat, soybeans, peanuts) waste recycling, water recovery and atmospheric recycling. Plants will supply 50% of diet for a crew of 4. Growing area is 60 Sq. M. Approximately 18 Kw of power is needed for plant growth with artificial lights and equipment operation. Also contains a food processing station, a harvesting station, monitoring and control instrumentation. Reference GDCD 1304 for commercial use. See GDCD 0341 which is a related mission.	tomato, wheat, soybeans, peanuts) lants will supply 50% of diet for power is needed for plant growth a food processing station, a Reference GDCD 1304 for commercial

ORIGINAL PAGE 19 OF POOR QUALITY

of 3			•		
3.4.2 Page 2 of 3			☐ Continuous	, (ZHW) A	(ZH
CODE 6.0.0.0.3.4.2	Tolerance + Ephemeris Accuracy, m	□Earth Field of view, deg —	Duration, hrs/day 1 cy, Hz	Other Frequency (MHZ)	Voice (Hrs/Day) Other Downlink Frequency (MHZ)
	igee, km Any	ortial Solar Soc. Solar Solar Soc. n adam	. •	Digit	
	T CHARACTERISTI Be, km Any Ination, deg I Angle, deg	POINTING/ORIENTATION Jiew direction Truth Sites (if known) Pointing accuracy, arc Pointing Stability (J	OUER Ac Operating Standby Peak		Data Types: Analog Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT Data Dump Frequency (PRECORDING Rate (KBPS)

C-6

ORIGINAL PAGE 19 OF POOR QUALITY

2	00	Stowed Deployed				-	40	e. Animal Food
CODE 6.0.0.03.4.2	#1n 3000 = ## 18	Remote Unpressurized 4.5 4.5 4.5 10.500 4.5 10.500 4.5 10.500 4.5 10.500 4.5		7 2 2 2	4 4 Hra/FUA	13,		ons components in event of power failur int food (TBD). Crew time for servi
	THERMAL MActive Passive Temperature, deg C operational m. non-operational m. Heat Rejection, w operational m.	EQUIPMENT PHYSICAL CHARACTERISTICS Location: Internal External Equipment ID/Function 5.5 U,m L,m 5.5 U,m L,m 5.5 U,m Launch mass, kg Consumables Types	2	Skills (See Table B) SKILL LEVEL	EUA TYES TX NO Reason	SERVICE Interval, days 90	interval, day Deliverables,	SPECIAL CONSIDERATIONS/Soo Instructions Back-Up Power: Needs definition for critical components in event of power failure. for Vivarium: May be obtainable from CELSS plant food (TBD). Crew time for service routine operations.

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

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GDCD CODE	B42 ELEMENT NAME	DEDICATED CELSS	MODULE
ACCOMODATION:	☑ ATTACHED ☐ FREE	FLYER - OTV OPS	3
	TION (E.G., SET-UP/ASSEMBLY/		
□ NOT APPLIC	ABLE		amen de la la la la la la la la la la la la la
2. SERVICE (E.G., RE	PLENISH/RESUPPLY)		
INTERVAL 90	_DAYS TOTAL SERVICES	_16	
TMS/OTV RE	EQUIRED	STATION HRS PE	R SERVICE
□ NOT APPLIC	ABLE	EVA HRS PER SEI	RVICE
		EVA CREW SIZE	
6 HRS PI HRS PI NOT APPLIC	ABLE ON ON ON ON ON ON ON ON ON ON ON ON ON	IGS. <u>2</u> Station hrs per	R RECONFIG. 40
3 ************************************		EVA CREW SIZE	
5. DEACTIVATION/R	IEMOVAL	EVA HRSEV	/A CREW
	ABLE		
6. NOTES (BRIEFLY	DESCRIBE TASKS IN 1 THROUG	GH 5 ABOVE)	
 Bring new Planting new Updating new 	t peculiar setup plants, seeds from e new crops, maintainin waste processing and peration continues at	ng crops other hardware	(incl. in station ops support)

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Code: GDCD 0342

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Dedicated CELSS Module

Reference Documents:

1. GDCD 0341, payload element synthesis for CELSS Experimental Systems

Narrative:

This payload development derives from Ref 1 for an operational CELSS in 1996, for a four person crew, providing 50% food (vegetables), 100% water/atmosphere. Ref 1 describes a CELSS experiment program starting from a 1992 launch with 1994, 1996 upgrades. From 1996 until 1998, the CELSS configuration should be close to the operational CELSS relative to size, weight, volume, and power. Numerical data are given in Ref 1.

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		Page 1 of
PAYLOAD ELEMENT NAME CELSS Pallet	CODE G D C D O 3 4 3	
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division		Applications (non-commercial)
San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Technology Development
STATUS	ned	Operations
	Opportunity	
First flight, yr 1996 No. of flights 1 Duration of Flight, days 2190 OBJECTIVE		(see Table A) Importance of the Space Station to this Element
Grow algae and yeast cultures for possible food use.	ood use.	1 = low value but could use 10 = vital
		Scale 1 - 10 10
Four 80 gallon tanks with windows for sunlight, will be mounted on a pallet attached to the CELSS located module. Three of the tanks will contain algae (e.g., spirulina) and one will contain yeast, for experiments related to food supplementation. Appropriate nutrient media is required with instrumentation to monitor and control chemical input/output and plumbing connecting the tanks to the CELSS module for harvesting. May need separate dump systems for algae and yeast.	ht, will be mounted or ll contain algae (e.g. od supplementation. A control chemical inpurvesting. May need se	with windows for sunlight, will be mounted on a pallet attached to the Three of the tanks will contain algae (e.g., spirulina) and one will speriments related to food supplementation. Appropriate nutrient media is nentation to monitor and control chemical input/output and plumbing conthe CELSS module for harvesting. May need separate dump systems for

ORIGINAL PAGE 19 OF POOR QUALITY

m			OF POOR QU	ALITY	
CODE 6 D C D O 3 4 3 Page 2 of	Tolerance + Tolerance + Ephemeris Accuracy, m	View direction [Jinertial Solar [Earth Truth Sites (if known) Pointing accuracy, arc sec Field of view, deg Pointing Stability (Jitter) arc sec/sec Special Restrictions (Avoidance)	JAC Ope Sta Pea	MUNICATIONS ng requirements: Realtime	Data Types: Analog XDigital Hrs/Day Film (Amount) X Occa (Hrs/Day) Live TU (Hrs/Day) 0.2 Other On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 1 Downlink Frequency (MHZ)

CODE 6 D C D O 3 4 3 Page 7 0 6	C
26	כ
l ain	
S L Remote ized V Unpressurized	
1.0 U,m 2.5 H,m	
Consumables Types Acceleration sensitivity, a min	
Tack Assignment Service P.	
oe Table B) SKILL 7	
LEVEL 1 2 Hrs/Da., 0.25 0.25	
stl/Monthly Insp	
1	
kg 150 Man Hours	
los, kgReturnah	
SPECIAL CONSIDERATIONS/See Instructions	
Pointing Characteristics: Sunlight required for number of hours/day to be determined by early experiments. Configuration Changes: Algae/yeasts can be used for food. Initially plant matter	
might be returned to Earth for testing; later, algae/yeast will be used for food preparation.	
Nutrient servicing is required. IV Monitoring: IU min/day is included for external systems status check.	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 0343 ELEMENT NAME	CELSS PALLET
ACCOMODATION: 🖾 ATTACHED 🗀 FRE	E FLYER
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY	/ATTACHMENT AND CHECKOUT)
DATE(S) 1996 INT. HRS 8	EVA HRS 6 EVA CREW 2
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 90 DAYS TOTAL SERVICE	<u> 16</u>
TMS/OTV REQUIRED	STATION HRS PER SERVICE 4
☐ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME	FOR MONITOR, INSPECT, ETC.)
0.5 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA) See Note	3
☐ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONF	igs
☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
	EVA HRS EVA CREW
▼ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROU	GH 5 ABOVE)
 Initial setup of plants EVA 0.5 hr to inspect 1/month Payload operation continues a 	= 27 hours total through 2000 fter 2000

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 0343

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: CELSS Pallet

Reference Documents:

 Life Sciences Considerations for Space Station, Life Sciences Division (EB-3), Office of Space Science and Application; NASA. Washington, D.C. 20546.

- 2. Controlled Ecological Life Support System (CELSS) Program Plan. NASA EBT-3/Chief, Biological Systems Research. March 1982.
- 3. Air Pollutant Production By Algal Cell Cultures by F. Fongand, E.A. Funkhouser in Controlled Ecological Life Support System. First Principal Investigators Meeting. NASA Conference Publication 2247. Published 1982.
- 4. CELSS Principal Investigators' Conference. (NASA). Abstracts. December 1982.

Narrative:

The use of a pallet for holding algae and yeast type cultures in tanks is based on the following reasons:

- Saves module space since the required culture environment is a water environment.
- Ease of exposing tanks (transparent) to sunlight.
- Reduced risk for toxic interaction with module environment.

The need for the cultures is in relation to CELSS food growth experimentation. Cultures are to be drawn off from the tanks into a work module for experimentation.

Ref 1, p 30 suggests the use of sunlight for transparent containers. Possible toxicity of cultures is noted in the literature, Ref 2, p 39 and Ref 3, p 57. The foregoing considerations suggest the use of a pallet.

Culture nominal temperature in the tanks will probably be in the range similar to the normal values for human beings (20 to 26 C). However, Ref 4, p 17 notes a test at 30 C with one culture type.

Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 0343

PAYLOAD ELEMENT SYNTHESIS

Four tanks are chosen to hold the cultures, each at 80 gallons. Ref 1, p 30 mentions tanks of about 200 gallons, however, the 80-gallon size seems suited to the pallet concept. Culture weight, water based, in 320 gallons is about 2500 lb; weight of four tanks (dry) is estimated at about 300 lb (minimum). Total weight, tank plus culture becomes 2800 lb. (1300 kg).

Section $\frac{1}{2}$. 5		
Discipline	Materials Processing	•	

GDCD ID NO.	PAYLOAD ELEMENT NAME
0400 0401	Research and Development Facility R&D/Proof of Concept Facility

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	Page 1 of 3
Research and Development Facility 6 0 C 0 0 4 0 0	•
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division Address p. p. p. p. p. p. p. p. p. p. p. p. p.	Applications (non-commercial)
San Ciego, CA 92138	- Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Tachnology Development
STATUS Descritonal Planned	Operations
☐ Approved . ⊠Candidate ☐ Opportunity	
First flight, yr 1990 No. of flights 1 Duration of Flight, days 1460	(See Table A) Importance of the Space Station to
OBJECTIVE <pre>Provide a small scale general purpose materials science research and development facility for early year operations.</pre>	
	Scale 1 - 10 10.
DESCRIPTION This facility contains processing and support equipment to conduct research and development experiments in the areas of solidification, crystal growth, bioprocessing and fluid, chemical and combustion experiments.	t research and development ocessing and fluid, chemical

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		ENTA ON CIF ULPEC TICL	rating ndby k	Monitoring requirent None None None None None None None None	Data Typos! Film (Amount) Live TV (Hrs/Da On-Board Storag Data Dump Frequ

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C D 0 4 0 0	13,000		Roq.	
CODE 6.0.0.0	XXXX acc	2 2.0 2.0 1.1s		
	min min 10,000	Remote Jungra 75	Consumables, Ram Hours kg f skills.	
	ational ational ational	Exterior Press 4.5 4.5 mass, mass, retired	1 Task Assign SKILL 5 LEVEL 2 Hrs/Day 2 Hrs/Day 2 NCE days Constant day Man GESiInterval, day Deliverables, kg Instructions red. Cross training of skills.	
	် 3	HYSICAL CHARA(X Internal D/Function L,m L,m L,m Launch Consum		
	THERMAL MActive Temperature, deg Heat Rejection,	EQUIPMENT PHYSICAL CH Location: XInternal Equipment ID/Function L,m	CREW REQUIREMENTS Crew Size Skills (See Table B) EUA	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 0400	ELEMENT NAM	RESEARCH AND	DEVELOPMENT FACILITY
	M ATTACHED ☐ FR		
1. STATION ACTIVAT	TION (E.G., SET-UP/ASSEMBI	Y/ATTACHMENT ANI	CHECKOUT)
DATE(S) 1990	INT. HRS	EVA HRS	EVA CREW
□ NOT APPLICA	ABLE	-	
2. SERVICE (E.G., RE	PLENISH/RESUPPLY)		
INTERVAL	DAYS TOTAL SERVIC	ES	
☐ TMS/OTV RE	QUIRED	STATION H	RS PER SERVICE
☑ NOT APPLICABLE		EVA HRS PER SERVICE	
		EVA CREW	SIZE
HRS PE	ABLE		1
TMS/OTV REQUIRED		STATION HAS PER RECONFIG.	
☑ NOT APPLICABLE		EVA HRS PER RECONFIG.	
		EVA CREWS	SIZE
5. DEACTIVATION/R DATE(S) 1994		EVA HRS	EVA CREW
□ NOT APPLICA	ABLE		
6. NOTES (BRIEFLY (DESCRIBE TASKS IN 1 THRO	UGH 5 ABOVE)	
3. Crew active record, lo package sa	tion operations rity description: ad/unload samples, mples. Repair equ ment operates 24 h	clean out equ	<pre>l/manipulate, measure/ ipment, preserve and ired.</pre>

TOTAL EVA HRS _____

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 0400

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Research and Development Facility

Reference Documents:

1. TRW Report MPS .6-80-286, Vol. II, "MEC Payloads Handbook," 30 January 1981.

Narrative:

This is a general purpose R&D facility for Materials Science research and physics and chemistry experiments in fluid behavior, chemical reactions and combustion. Limited product analytical capabilities are included, therefore, most analyses must be conducted after the products are returned to ground laboratories.

The facility contains three sets of processing modules and three corresponding support modules as shown below.

Processing Module	Support Module	Pwr <u>kW</u>
ASES/HGDS (1) FZ (1) VCG (1) SCG (1)	} 1	1.5-10.
BIO (2) F/C (1)	1 1	0.5-3.0 0.2-1.0

Since the four furnaces share one support module, only one can be operated at a time.

Equipment physical characteristics were derived from Ref 1. They are summarized in Table 0400-1.

Launch date and mission duration were derived.

The following general comments apply to 0400, 0401, and 1200 thru 1205:

Code: GDCD 0400

PAYLOAD ELEMENT SYNTHESIS

- 1. Description data for all attached payload elements is based upon MPS .6-80-286, Vol. II, MEC Payloads Handbook (TRW). All mass and volume values include a 25% growth factor.
- Power levels shown are for the largest specimen sizes.
- 3. Abbreviations used are as follows:

AC	Acoustic Containers
ASES	Advanced Solidification Experiment System
BIO	Biological
CFE	Continuous Flow Electrophoresis
EMC	Electromagnetic Containerless
ESC	Electrostatic Containerless
FZ	Floating Zone
F/C	Fluids/Chemistry
HGDS	High Gradient Directional Solidification
IEF	Isolectric Focusing
SCG	Solution Crystal Growth
SEC	Stationary Electrophoresis Column
VCG	Vapor Crystal Growth

4. The source data expresses equipment size in terms of volume rather than dimensions. In a manned laboratory the equipment would be packaged in equipment racks, or with dimensions similar to racks. Therefore, to derive the L by E by H dimensions required for the Payload Element Data Sheets, rack cross-sections of 2m high by 0.75m deep were assumed. The rack length was then calculated by: $L = \frac{V}{1.5}$ m

Page 3 of 3 Volume II, Book 1 Appendix I

Code: GDCD 0400

PAYLOAD ELEMENT SYNTHESIS

Table 0400-1 EQUIPMENT PHYSICAL CHARACTERISTICS

PROCES:	c		ESSING DULE		PORT	TOT	ALS
(QTY)	3	MASS kg	VOLUME m3	MASS kg	VOLUME m3	MASS kg	VOLUME m3
ASES/HGDS FZ VCG	(1) (1) (1)	51 2 186 100	1.4 0.5 0.5	4.00	2 25	1226	£ 15
SCG	(1)	50	0.5	488	2.25	1336	5.15
BIO Fluids/	(2)	30	0.1	170	0.5	200	0.6
Chemi stry	(1)	120	0.5	80 T(0.5 TAL	200 1736 kg	1.0 6.75 m3

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		Page 1 of
AME	CODE	
K&U/Proof of Concept Facility	7	X and the X
CONTACT W. Hardy/J. Peterson MZ 21-9530		Applications
0.55		
	<u>.</u>	Commercia(
Telephone (619) 277-8900, Ext. 3778/2130		Technology
STATUS		Jaca Lopagnt
nal	0	Operations
☐ Approved ☐ Scandidate ☐ Opportunity	Tubo	Number 5
r 1994	(300	Table A)
No. of flights 1 2555 Duration of Flight, days	Todel	Importance of the
	this	
Provide moderate scale general purpose materials science research and development facility for mid- and late-year operations.	1 01	low value but could use vital
	Scale 1	1 - 10
DESCRIPTION		
This facility contains processing and support equipment to conduct research and development proof of concept experiments in the areas of solidification, crystal growth, containerless processing, bioprocessing and fluid, chemical and combustion experiments.	t to conduct resea ation, crystal grc ustion experiments	arch and development owth, containerless s.

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m			OF POOR QUAL		
6.0 C.0 0 4.0 1 Page 2 of			Continuous	Fraquency (MHZ)	2 2 MHZ)
CODE 6,0,0,0	Tolerance + Ephemeris Accuracy.	ar Earth 	U Duration, hrs/day 2 Frequency, Hz	Other	tal
	CTERISTICS >400 Periges, km >400 deg Any deg	TION Inertial Solar known) U,arc sector (Jitter)arc sector (Auther)arc sector s	X DC Power, 25,000 150 35,000	A/COMMUNICATIONS Ltoring requirements! None XRealtime XOffline Encryption/Decryption Required Uplink Req.:Command Rate (KBS) On-Board Data Processing Required Description	Analog Digital Obay Cage (MBIT) Ca
	ORBIT CHARACTERIS Apoges, km >400 Inclination, deg Nodal Angle, deg	OINTING/ORIENTA low direction ruth Sites (If ointing accurac ointing Stabili	PCUER Operating Standby Ponk	DATA/COMMUNICATIO Monitoring requir None Encryption/De Uplink Req.:C XOn-Board Data Description	Data Types! Film (Amount) Live TU (Hrs/I On-Board Store Data Dump Free

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c			· POOR QUALITY	
CODE 6.0.0.0.4.0.1	35,000	rial Remote surized Unpressurized Types	Assignme Consum Man Horsesskills.	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 0401 ELEMENT NAME R&D	/PROOF OF CONCEPT FACILITY
ACCOMODATION: MATTACHED - FREE FLY	ER 🔲 OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	ACHMENT AND CHECKOUT)
DATE(S) 1994 INT. HRS EVA	HRSEVA CREW
NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR N	IONITOR, INSPECT, ETC.)
8 HRS PER DAY (INTERNAL) 26 days	s per month
HRS PER DAY (EVA)	•
☐ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONFIGS.	
☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) INT. HRS EVA H	URS EVA CREW
101.1110.	
■ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	ABOVE)
 and 5. Station operations Crew activity description: monit load/unload samples, clean out eq and package samples. Repair equi Some equipment operates 24 hours 	or, control/manipulate, measure/record, uipment, analyze samples, preserve pment as required. per day.

TOTAL EVA HRS 0

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 0401

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Research & Development/Proof of Concept Facility

Reference Document:

1. TWR Report MPS .6-80-286, Vol. II, "MEC Payloads Handbook", 30 January 1981.

Narrative:

This facility provides materials Science R&D capabilities in all MPS areas, and supports proof of concept experiments. It includes the same furnace and fluids/chemistry equipment as P/L-0400, but expands the BIO capabilities by a factor of three and adds containerless processing capabilties. Moderate product analysis capabilties are included.

The facility contains four sets of processing modules and four corresponding sets of support modules as shown below

PROCESSING	MODULE	SUPPORTMODULE	Pwr, kW
ASFS/HGDS FZ VCG SCG AC	(1) (1) (1) (1)	1	1.5-20
EMC	$\langle i \rangle$	1	2.5-25 25/35
ESC BIO F/C	(1) J (6) (1)	1 1	1.0-10 0.2-1.0

The furnaces share support modules and only one can be operated at a time per support module.

Equipment physical characteristics were derived from Ref 1. They are summarized in Table 0401-1.

Launch date and mission duration were derived.

Code: GDCD 0401 PAYLOAD ELEMENT SYNTHESIS

- 1. Description data for all attached payload elements is based upon MPS .6-80-286, Vol. II, MEC Payloads Handbook (TRW). All mass and volume values include a 25% growth factor.
- 2. Power levels shown are for the largest specimen sizes.
- Abbreviations used are as follows:

AC	Acoustic Containers
ASES	Advanced Solidification Experiment System
BIO	Biological
CFE	Continuous Flow Electrophoresis
EMC	Electromagnetic Containerless
ESC	Electrostatic Containerless
FZ	Floating Zone
F/C	Fluids/Chemistry
HGDS	High Gradient Directional Solidification
IEF	Isolectric Focusing
SCG	Solution Crystal Growth
SEC	Stationary Electrophoresis Column
VCG	Vapor Crystal Growth

4. The source data expresses equipment size in terms of volume rather than dimensions. In a manned laboratory the equipment would be packaged in equipment racks, or with dimensions similar to racks. Therefore, to derive the L by W by H dimensions required for the Payload Element Data Sheets, rack cross-sections of 2m high by 0.75m deep were assumed. The rack length was then calculated by: $L = \frac{V}{1.5}$ m

Page 3 of 3 Volume II, Book 1 Appendix I

Code: GDCD 0401

PAYLOAD ELEMENT SYNTHESIS

Table 0401-1 EQUIPMENT PHYSICAL CHARACTERÍSTICS

PROCESS		ESSING DULE		PORT ULE	TOT	ALS
(QTY)	MASS kg	VOLUME m3	MASS kg	VOLUME m3	MASS kg	VOLUME m3
ASES/HGDS (1) FZ (1) VCG (1) SCG (1)	51 2 1 86 100 50	1.4 0.5 0.5 0.5	488	2.25	1336	5.15
AC (1) EMC (1) ESC (1)	288 350 288	1.0 1.1 1.0	412	1.5	1338	4.6
BIO (6) Fluids/ Chemistry (1)	90 120	0.3	260 80	0.9	350 200	1.2
			TO	TAL	3224 kg	11.95 m3

COMMERCIAL MISSIONS

Volume II, Book 1 Appendix I

2.1

Discipline Earth and Ocean Observations

GDCD ID NO.	PAYLOAD ELEMENT NAME
1000	Geological Reconnaissance
1001	Remote Atmospheric Sensing
1002	Worldwide Cotton Acerage and Production
1003	Petroleum and Mineral Location

	Page 1 of 3
PAYLOAD ELEMENT ***	TYPE
al Keconnalsochee	Science &
W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division	
Hddross P.O. Box 85357	
Telephone (619) 277-8900, Ext. 3778/2130	- Technology
STATUS	3 1 0 E Q 3 E A A A A A A A A A A A A A A A A A A
Operational Operational	Operations
n objection of	Number
First flight, yr 1990	(see Table A)
No. of flights 1	Importance of the
	this Element
de j.	1 - low value but
reservoirs or for seismic location, or possibly for weather monitoring.	could use 10 - vital
	Scale 1 - 10 2
DESCRIPTION	
Use station to test experimental scanners, change out modules, build modular satellites and launch into polar orbit. Use LANDSAT-type experimental Earth scanning systems for exploration,	uild modular satellites and uning systems for exploration,
probably in a sun synchronous polar orbit. May involve joint venture for iceberg and weather tracking for offshore platforms, seismic boats. The exploration phase using free flyer is described herein.	ture for iceberg and weather chase using free flyer is
Ref. GDCD 0174 or GDCD 0175 could accommodate development/test of scanners. Ref. GDCD 0172 could accommodate the exploration phase.	scanners.
·	

9					
CODE 6.0.0.0.0.0 Page 2 of 3	pogee, km 500 Periges, km 500 Tolerance + 100 nclination, deg 90 Tolerance + 10 codel Angle, deg Ephemeris Accuracy, m	OINTING/ORIENTA law direction ruth Sites (if ointing accurac ointing Stabili pecial Restrict	OWER Ac Operating Standby Peak	MMUNICATIONS Ing requirements: "Realtime Of "Yption/Decryption Requirence of Command Rate (K) Board Data Processing Recription	Data Types: Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)
	S d in S	STATES	3	8 9	

CODE G.D.C.D.1.0.0 0
min max
Heat Rejection, w operational min max
RACTERISTICS
E'T
0001 -
IREMENTS
Skills (See Table B) SKILL
LEVEL Hrs/Dav
EUA - VES XNO Reason Hrs/FUA
Returnables, kg Man Hours
day los, ka
lons
1) Desire polar sun synchronous orbit for Earth scanning orbits necessary to monitor weather in areas of seismic or drilling/production activity.
2) Keal time data downlink at 100MBPS (from free-flyer). 3) Equipment may be sensitive to radio activity and to RF/magnetic fields; equipment may generate RF/magnetic fields. 4) Experi- ment requires ON/OFF commands from ground (free-flyer).

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 1000 ELEMENT NAME	GEOLOGICAL RECONNAISSANCE
ACCOMODATION: ATTACHED FREE	FLYER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY	/ATTACHMENT AND CHECKOUT)
DATE(S) 1990 INT. HRS	EVA HRSEVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	<u> </u>
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME	FOR MONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
MOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONF	ilige
☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
■ NOT APPLICABLE	EVA HRS PER RECONFIG.
MU! AFFLICABLE	EVA CREW SIZE
	EAM CUEM 2175
5. DEACTIVATION/REMOVAL	
DATE(S) 1995 INT. HRS.	EVA HRS EVA CREW
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROU 1. and 5. are accounted for in which accommodates the	GH 5 ABOVE) GDCD 172 payload requirements of the payload element.

Page 1 of 1 Volume II, Book 1 Appendix I

Code: GDCD 1000

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Geological Reconnaissance

Reference Documents:

1. Mobil Research & Development Corporation, USer Fact Sheet

Narrative:

Ref 1 describes a two-phase plan: 1) Station attach for experimental phase; 2) free-flyer for operational phase. The payload element described is the commercial free-flyer.

All data is based on REF 1.

GDCD Payload elements 0174 and 0175 in the Science and Application - Earth Exploration Discipline appear adequate to provide sensors and facility in which experimental development can be conducted. GDCD Payload element 0172 could accommodate the operational needs for Landsat-type data.

		Page 1 of 3
PAYLOAD ELEMENT NAME	CODE	TYPE
Remote Atmospheric Sensing	6 0 c 0 1 0 0 1	Science &
W. Hardy/ General D		Applications (non-commercial)
		X Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Tachnology Development
STATUS	90	Operations
,	Candidate Opportunity	Type Number 6
First flight, yr 1990 No. of flights 1 Duration of Flight, days 3650 OBJECTIVE		(see Table A) Importance of the Space Station to this Element
To detect and map atmospheric pollutant concentrations on a real time basis, as well as other weather parameters (clouds, wind) for validating effects of power plant operations and to optimize 10 short term load forecasts for system operation purposes.		- low value but could use - vital
		Scale 1 - 10
DESCRIPTION Monitoring atmospheric properties on a roperations by minimizing emissions and optimizing system ments to power plan commitments in an economical manner. visioned by user for operational phase (described herein by space station could prove cost effective. Reference GDCD 0262 measurement of atmospheric pollution date instrument development.	erties on a real-time mizing system operatio mical manner. A geosy cribed herein), howeve ric pollution from sat	toring atmospheric properties on a real-time basis will enhance system zing emissions and optimizing system operations by matching load require-commitments in an economical manner. A geosynchronous satellite is enoperational phase (described herein), however, instrumentation development all prove cost effective. measurement of atmospheric pollution from satellites (MAPS) could accommodiopment.

m						
GDE GDCD1001 Page 2 of 3	Tolerance + Ephemeris Accuracy, m	nortial Solar Earth : soc Field of view, deg Jitter)arc soc/soc Desire Earth Swaths	16 500 - 1000 Duration, hrs/day	Of Requir	Digit	BPS) Downlink Frequency (MHZ)
	ORBIT CHARACTERISTICS Apogee, km 35,786 Perigee, Inclination, deg Nodel Angle, deg Escane dU Regulred.m/s	ING/ORIENTATION firection Ir Sites (if known ing accuracy, arc ing Stability (J	OUER Operating Standby Peak	MMUNICATIONS Ing requirements: [XRealtime ryption/Decryption Re ink Req.: Command Rate Board Data Processing cription neral Purpose Computer	Ana Day Cage (Misquency	rding Rate (KBP

THERMAL Temperature, deg C operational min Heat Rejection, w operational min ROUIPMENT PHYSICAL CHARACTERISTICS
ID/Functi
B) SKILL LEVEL Hrs/Day
SERVICING/MAINTENANCE SERVICE:Interval, days Returnables, kg CONFIGURATION CHANGES:Interval, day Deliverables, kg Returnables, kg Returnables, kg

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE_	1001 E	LEMENT NAME	REMOTE	ATMOSP	HERIC SI	ENSING	
	ON: ATTACH						
	CTIVATION (E.G., SE						_
□ NOT	APPLICABLE						
2. SERVICE (E	E.G., REPLENISH/RES	SUPPLY)					
INTERVAL	DAYS	TOTAL SERVICE	s				
TMS/	OTV REQUIRED		ST	ATION HR	S PER SERV	/ICE	
Ø NOT	APPLICABLE		EV	A HRS PE	R SERVICE		_
			Ę۷	A CREWS	SIZE		
4. RECONFIG	APPLICABLE URATIONDAYS	TOTAL RECON	FIGS				
☐ TMS/	OTV REQUIRED		STA	ATION HR	S PER RECO	NFIG.	
⊠ NOT A	APPLICABLE		EV	A HRS PEF	R RECONFIC	i	_
	_		EV	A CREW SI	IZE	•	
5. DEACTIVA	TION/REMOVAL						
DATE(S) _2	2000 INT. HR	s	EVA HRS _	<u> </u>	_ EVA CRE		_
☐ NOT	APPLICABLE		-				_
6. NOTES (BR	IEFLY DESCRIBE TA	SKS IN 1 THROU	GH 5 ABO\	/E)			
1. and 5.	are accounte payload whic element.		ites the	requi	rements	GDCD 0262 of this pa	

TOTAL EVA HRS 0

Page 1 of 1 Volume II, Book 1 Appendix I

Code: GDCD 1001

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Remote Atmospheric Sensing

Reference Documents:

1. Southern California Edison Company, User Fact Sheet.

Narrative:

Ref 1 describes a geosynchronous orbit accommodation for real-time pollutant monitoring. Instrument development for this commercial application could be accommodated on a NASA Science and Applications payload element (GDCD 0262) Measurement of Air Pollution from Satellite (MAPS). The operation satellite would also monitor those weather conditions relative to pollutant monitoring and contributing to optimizing power plant operations. Geostationary Operational Environmental Satellite (GOES) Follow-on GDCD 0206 could provide the desired real-time coverage for this payload element.

The start date for this payload element is estimated; the remaining data is from Ref 1.

	Page 1 of 3
CODE	TYPE
Cotton Acreage and Production	- Science &
CONTACT W. Hardy/J. Peterson MZ 21-9530	Applications (non-commercial)
San Diego, CA 92138	X Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Tachnology Development
	Onerations
Operational	9
Opportunity	
First flight, yr 1990 No. of flights 1 >1825 Duration of Flight, days	Importance of the Space Station to
	this Eloment
Provide more timely and accurate estimates of cotton acreage and production around the world.	1 - low value but could use 10 - vital
	Scale 1 - 10
DESCRIPTION The interest would be in providing similar information to that provided by LANOSAT IV more reliability at a lower cost and with greater sophistication. Requirements satisfied by 60CD 0172.	provided by LANOSAT IV more Requirements satisfied by

F 3					
6.0.c.01.0.0.2 Pege 2 of 3	500 Tolerance + Ephemeris Acc	Solar Earth		D C X S S S S S S S S S S S S S S S S S S	Orbit) Dounlink Frequency (MHZ)
	ORBIT CHARACTERISTICS Apogee, km 500 Perigee, km Inclination, deg 45 Nodal Angle, deg Escape do Required, m/s	NTATION If known) Iracy, arc sec Ittly (Jitter) arc	OUER Ac Do Power, Operating Standby Peak	TA/COMMUNICATIONS Litering requirements: None Realtime Of Encryption/Decryption Requirements Uplink Req.: Command Rate (K) On-Board Data Processing Rec	Data Types: Analog DI Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit)

CODE 6 D C D 1 0 0 2	
	5
Active Passive	
non-operational m	
Heat Rejection, w operational min	
PHYSICAL CHARACTERISTICS	
Location: Linternal External Memote Equipment ID/Function DPressurized Unpressurized	
L's Total L's To	
7. T.	
Types	
CREU REGULARENTS	
se Table B) SKILL	
LEVEL	
Hrs/Day	
EUA DYES XNO Ranson Hrs/EUA	
ANCE	
Js Cons	
Man Hours	
100.3	

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 1002 ELEMENT NAME	COTTON ACREAGE AND PRODUCTION
ACCOMODATION: ATTACHED THE	FLYER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/	ATTACHMENT AND CHECKOUT)
DATE(S) 1990 INT. HRS	EVA HRS EVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
X NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME F	OR MONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	•
☑ NOT APPLICABLE .	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONF	IGS.
☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) 1995 INT. HRS E	EVA HRS EVA CREW
□ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUG	ih 5 ABOVE)
1. and 5. are accounted for in	GDCD 0172 payload

TOTAL EVA HRS ______

Page 1 of 1 Volume II, Book 1 Appendix I

Code: GDCD 1002

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Worldwide Cotton Acreage and Production

Reference Documents:

1. Cotton Incorporated, User Fact Sheet

Narrative:

Flight date and orbit altitude data is derived. The remaining data is from Ref 1. NASA Payload element GDCD 0172 Operational Land Systems is adequate to accommodate this payload element requirements.

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	Page 1 of
PAYLOAD ELEMENT NAME Petroleum and Mineral Location G D C D 1 0 0 3	TYPE
W. Hardy/J. Peterson MZ 21-9530 General Oynamics Convair Division	Applications (non-commercial)
Hddr oss P.G. Box 85357 San Diego, CA 92138	⊠ Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Tachnology
STATUS	Operations
	Type Number 6
First flight, yr 1990 No. of flights 1 Duration of Flight, days 1825 OBJECTIVE	Importance of the Space Station to this Element
To locate petroleum and mineral deposits.	1 - low value but could use 10 - vital
	Scale 1 - 10 3.
DESCRIPTION New sources for natural resource data will eventually be required. Large focal length cameras and/or high resolution scanners will be required to obtain multispectural images of the Earth's land mass, which will be used to increase knowledge of surface geology and improve exploration efforts for mineral resources. Objectives accomplished by GDCD 0172.	quired. Large focal length cameras multispectural images of the of surface geology and improve
•	

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6		} 	1 11		 1		<u>, , , , , , , , , , , , , , , , , , , </u>
CODE 6 0 0 1 0 0 3 Page 2 of		OINTING/ORIENTA low direction ruth Sites (If	Stability (Jitter)arc sec/sec lestrictions (Avoidance)	Operating Power, U Duration, hrs/day	Peak Voltage, V Frequency, Hz	MUNICATIONS ng requirements; Realtime Of Uption/Decryption Requirent Req.: Command Rate (K) oard Data Processing Recription	Data Types: Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

r	1	177 (177		
CODE G.D.C.D.1.0.0.3 Page 3 of	1	rnal Remote surized Nupressurized W,m H,m H,m kg kg	Assignment Consumables, kg Ran Hours Ran/Hrs Req. Ons min; descending node equatorial crossigh resolution scanners assumed vs film on duration to retrieve/resupply film.	

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 1003 ELEMENT NAME	PETROLEUM AND MINERAL LOCATION
ACCOMODATION: ATTACHED A FREE	E FLYER
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY	/ATTACHMENT AND CHECKOUT)
DATE(S) 1990 INT. HRS	EVA HRS EVA CREW
	
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	5
☐ TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME	FOR MONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
▼ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONF	FIGS.
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
•	EVA HRS EVA CREW
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROU	GH 5 ABOVE)
 and. 5 are accounted for in which accommodates the Assumes electronic sensors vs 	GDCD 0172 payload requirements of this payload element film

Page 1 of 1 Volume II, Book 1 Appendix I

Code: GDCD 1003

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Petroleum and Mineral Location

Reference Documents:

1. Amoco Production Co., User Fact Sheet

Narrative:

The data is based on Ref 1 that suggests two possibilities for future natural resources data acquisition:

- 1. Cameras
- 2. High Resolution Scanners

The High Resolution Scanner approach was selected as most cost effective for the 1990 era to reduce logistic requirements and the probability of multiple service trips by the spacecraft or STS or TMS/OTV to retrieve/resupply film. A free-flyer accommodation was assumed due to the specific orbit paramaters required by the payload element.

The weight of this P/L element is for sensors only, which would be accommodated as part of a Leasecraft-type spacecraft.

Objectives accomplished by 0172.

Section 2.2

Discipline Communications

GDCD ID NO.	. PAYLOAD ELEMENT NAME
1100	Small Communication Satellite
1101	Medium Communication Satellite
1102	Large Communication Satellite
1103	Experimental Geo Platform
1104	Operational Geo Platform
1105	Reserved
1106	Large Deployable Antenna
1107	RFI Measurements
1108	Laser Communications
1109	Open Envelope Tube
1110	Spaceborne Interferometer
1111 .	Millimeter Wave Propagation

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Small Communication Satellite Source to the communication Satellite Source to the communication Satellite Source to the communication Satellite Source to the communication Satellite Small Communication Satellite San Diego, CA 92138 San Diego, CA 92138 Source to the communication satellites (delivered to Space Station to the sate to a single Off boost stage for transfer and injection into GEO. No servicing or per year through 2000.
Commercial (non-commercial) State
Scale Scal
Candidate Candidate Coperations Candidate Ca
Candidate Candidate Candidate Candidate Candidate Cae Table A) Type Number Cae Table A) Importance of the Space Station to this Element Lhis Element Could use 10 - vital Scale 1 - 10 5 Scale 1 - 10 5 State in to OTV Unication satellites (delivered to Space Station by Shuttle), will ost stage for transfer and injection into GEO. No servicing or these satellites. Number of flights based on 5 to 10 flights
Some Table A) Candidate
Importance of the Space Station to this Element In these satellites. Number of flights based on 5 to 10 flights Importance of the Space Station by Shuttle), will stage for transfer and injection into GEO. No servicing or these satellites. Number of flights based on 5 to 10 flights
e, mate it to OTV for transfer and could use could use 10 - vital 10 - vital 20 - vital 5 - Scale 1 - 10 5 - Scale 10 - 10 5 - Scale 10 - 10 5 - Scale 10 - 10 5 - Scale 10 - 10 Station by Shuttle), will st stage for transfer and injection into GEO. No servicing or no these satellites. Number of flights based on 5 to 10 flights
feale 1 - 10 5 5 11 11 provide an economic benefit. Assuming a space-based OTV ication satellites (delivered to Space Station by Shuttle), will stage for transfer and injection into GEO. No servicing or these satellites. Number of flights based on 5 to 10 flights
will provide an economic benefit. Assuming a space-based OTV ication satellites (delivered to Space Station by Shuttle), will t stage for transfer and injection into GEO. No servicing or these satellites. Number of flights based on 5 to 10 flights

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C			OF PO	OR QUALI	i TY ,	
GODE GDCD1100 Page 2 of	ORBIT CHARACTERISTICS Apogne, km 35,786 Periges, km 35,786 Tolerance + Inclination, deg 0 Tolerance + Nodal Angle, deg Ephemeris Accuracy, m Escane do Regulred.m/s	OINTING/ORIENTATION Jow direction Inertial ruth Sites (if known) ointing accuracy, are see	Restrictions (Avoidance)	Operating Power, W Duration, hrs/day Standby Continuous Peak Voltage, V	MMUNICATIONS Ing requirements: Caltime Of Caltime Of Caption Command Rate (Kink Raq.: Command Rate (Kink Rate Caption Cate) Calption	Data Types: Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

ORIGINAL PAGE 18 OF POOR QUALITY

	G D C D 1 1 0 0
THERMAL Hotive Passive Temperature, deg C operational min	
Heat Rejection, w operational min	Xae
	urizad
L, m 2 U, m 4.5	He Banlound
Consumables Types	<816
CREU REQUIREMENTS	BIN HOX
Crew Size 2 Task Assignment	Payload Manipulation
	7
LEUEL	2
{	4
EUA 🗌 YES 🖾 NO ROBSON	Hrazeua
SERVICING/MAINTENANCE	
Cons	iles, kg
1	M
De Liverables, kg	Returnshies Ve
SPECIAL CONSIDERATIONS/See Instructions	1
1) Sizes and weights can vary considerably within this general group of payloads.	neral group of payloads. These pay-
only during OTV transfer operations. 2) Power will be self-supported.	O with a PAM-D. Crew required

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 1100 ELEMENT NAME SMAL	COMMUNICATIONS SATELLITES
ACCOMODATION: ATTACHED S FREE FLYI	ER 🛛 OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	CHMENT AND CHECKOUT)
DATE(S) 1990 INT. HRS 8 EVA	IRS EVA CREW
thru 2000	
NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	
TMS/07V REQUIRED	STATION HRS PER SERVICE
X NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR M	ONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
NOT APPLICABLE	•
4. 35000510110 477011	
4. RECONFIGURATION INTERVAL DAYS TOTAL RECONFIGS.	
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) INT. HRS EVA H	RS EVA CREW
☑ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 A	ABOVE)

 Task is to transfer satellite to OTV (when available) and verify mating operations (2 men x 4 hrs. = 8 man hours)

TOTAL EVA HRS _____

Page 1 of 5 Volume II, Book 1 Appendix I

Code: GDCD 1100

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Small Communications Satellite

Reference Documents:

- 1. Space Station Study, Commercial Communications Satellites, SPACECOM, Feb. 83. (GDC subcontract)
- Task II Report Planning Assistance for the 30/20 GHz Program Worldwide Market Demand Forecast, Western Union Report Sponsored by NASA, June 1981.
- 3. STS Mission Model 1983-2000, Advanced Planning Division, NASA Headquarters, Dec. 10, 1982
- 4. Mission Requirements and Network Support Forecast (STDN No. 803), Goddard Space Flight Center, Dec/Jan 1982/1983
- 5. The Satellite Communications Market in North America, 1982-1991, Frost and Sullivan, July 1981
- 6. The Market, SPACECOM Study, 4-5/1982 Presentation
- 7. Space Operations Center Systems Analysis Study Extension, Final Report, Volume I Executive Summary, By Boeing Aerospace, January 1982.
- 8. Growth and Status of Commercial Communications Satellites, NASA/LeRC, Oct. 15, 1982
- 9. A 25-Year Forecast for Commercial COMSATS and the Congestion of the Geostationary Arc, Future Systems Inc., Nov. 1977
- 10. Future of Communications Satellites, STS Users Conference, Sept. 1982, By Goddard Space Flight Center
- 11. National Space Outlook, National Space Club, June 22-23, 1982
- 12. Nominal Mission Model, Rev. 6, PSOI MSFC, 30 Sept. 1982.

Narrative:

The method used to estimate commercial communication satellite traffic is documented in Ref 1. References 2-11 contain projections made in various studies and were used as primary sources. Plots of seven principal traffic projections are in Figure 1. Figure 2 presents the two extremes and an average of Figure 1 data. Not all of these data distinguish between satellite sizes.

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Code: GDCD 1100

PAYLOAD ELEMENT SYNTHESIS

Table 1 presents traffic projections for three size classes of satellites as made by three separate sources (Ref 9, 7, 3) along with an average. The averages from Figure 2 and Table 1 are essentially equal. Ref 12 and internal analyses were used to validate satellite weights. Lengths were derived based on a modest improvement in density from current satellites. As most of the missions occur in the frame when an OTY is available, kick motors are not included. A more optimum packaging design could be forecast, which would reduce transportation costs.

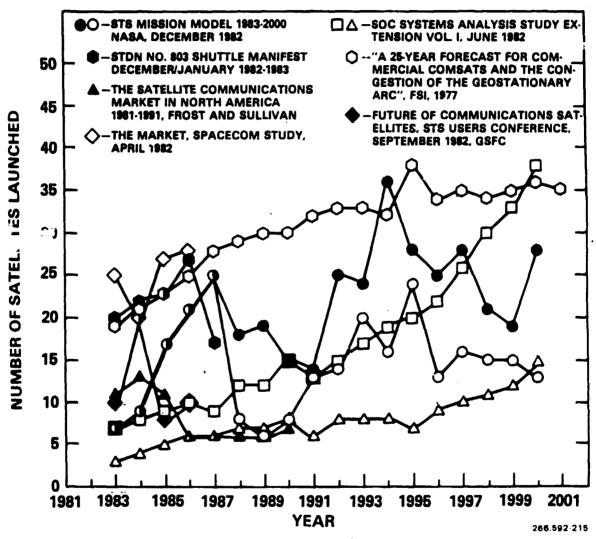
Separate payload elements are defined for each payload class and identified as small, medium, and large communication satellites.

Page 3 of 5 Volume II, Book 1 Appendix I

Code: GDCD 1100

PAYLOAD ELEMENT SYNTHESIS

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Geosynchronous Launches Reference Summary

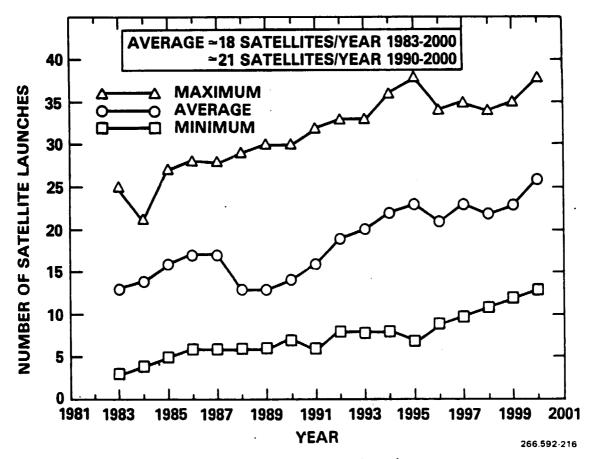
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Code: GDCD 1100

PAYLOAD ELEMENT SYNTHESIS

ORIGINAL PAGE 19 OF POOR QUALITY



Total Geosynchronous Launches



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Code: GDCD 1100

PAYLOAD ELEMENT SYNTHESIS

		MODEL A			MODEL B			MODEL C			AVG.	
YEAR	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE
81	_	-	_	5/3*	0	0	_	-	-	4	0	0
82	9	8	0	3/2	0	0	-	_	-	5	4	0
83	10	8	1	5/2	2/1	0	5	0	2	5.5	3	1
84	10	9	2	5/3	3/1	0	7	0	2	6	3	1
85	14	8	1	5/3	3/2	1	17	0	0	10	3	1
86	9	12	4	4/4	4/2	2/0	17	2	2	8.5	5	2
87	12	10	6	0/3	4/3	5/0	21	4	0	9	5	2
88	11	12	6	0/4	3/3	9/0	12/7	3/0	3/1	7	4	4
89	14	10	6	0/3	0/3	12/1	10/6	5/0	4/0	L	4	6
90	11	12	7	0/2	0/5	15/1	10/5	3/2	2/1	6	4	5
91	11	12	9	0	0/5	13/1	9/9	3/1	2/3	6	4	6
92	10	13	10	0	0/5	15/3	20/10	3/2	2/2	8	6	6
93	13	11	9	0	0/5	17/3	22/13	1/4	1/3	10	4	7
94	11	10	11	0	0/1	19/7	26/14	0	10/2	10	3	10
95	11	16	11	0	0	20/7	17/21	3/0	8/3	10	4	10
96	8	13	13	0	0	22/9	12/6	3/0	10/7	5	3	12
97	9	13	13	0	0	26/10	17/11	0	11/5	7	3	13
98	11	11	12	0	0	30/11	12/9	0	9/6	6	3	14
99	8	13	14	0	0	33/12	14/10	0	5/6	6	3	14
00	6	13	17	0	0	38/15	17/10	0	11/3		3	_17_
01	8	13	14		_] _		_	8	13	14
02	7	12	18			l <u> </u>	I	1 =	l <u>-</u>	, ,	12	18

SMALL UP TO 1800 lbs. (RCA SATCOMHUGHES 376 CLASS)
MEDIUM 1900-4500 lbs. (FORD INTELSAT V CLASS)
LARGE 5100 lbs. + (TDRSS CLASS)

*HIGH/LOW MODEL

266.592-217

Satellite Launch Prediction by Mass

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		Page 1 of 3
PAYLOAD ELEMENT NAME Med. Communication Satellite	CODE 6 0 C 0 1 1 0 1	TYPE
		Applications (non-commercial)
Haarass P.O. Box 85357 San Diego, CA 92138		X Commercia!
Telephone (619) 277-8900, Ext. 3778/2130		Technology Development
STATUS X Operational	ned	Operations
00	Candidate Opportunity	Type Number
First flight, yr 1990 No. of flights 40 Duration of Flight, days 1		(see Table A) Importance of the Space Station to
OBJECTIVE		this Elomont
iranster payload trom snuccie, mate it to div for transfer to GEO.	V TOT LTAINSTET LO	1 = low calue but Could use 10 = vital
		Scale 1 - 18 5
DESCRIPTION		
Space station will provide an economic benefit assuming a space based OTV is available, multiple communication satellites (delivered to Space Station by Shuttle) will be mated to single CTV boost stage for transfer and injection into GEO. No servicing or checkout will performed on these satellites. Number of flights based on 3 to 6 flights per year through 2000.	conomic benefit assuming a space based OTV ses (delivered to Space Station by Shuttle) isfer and injection into GEO. No servicing Number of flights based on 3 to 6 flights	Shuttle) will be mated to a servicing or checkout will be flights per year through

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C		UF FO	,010 Q = 11		
CODE 6 0 0 1 1 0 1 Page 2 of 3	ERISTICS 36,786 Perigeo, km 36,786 Tolerance + deg 0 Tolerance + deg Ephemeris Accuracy, m	IENTATION Lon		nts! time Of time Stion Requirent Rate (K)	osi Analog Digital Hre/Day ount) (Hrs/Day) Storage (MBIT) p Frequency (Per Orbit) g Rate (KBPS)
	ORBIT CHARACTERIS Apogee, km 36,78 Inclination, deg Nodal Angle, deg	INTERIOR DE LA COLOR DE LA COL	OUER Ac Operating Standby Peak	MUNICATI ng requi uption/D nk Req.; oard Dat	400 7 8

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CODE 6 D C D 1 1 0 1	1 Page 3 of	C
THERMAL Active Passive Temperature, deg C operational min max non-operational min max Heat Rejection, w operational min max non-operational min max) <u></u>
S Kemote ized Unpressurize .m 45 H.m M A 5 H.m	Stowed	
Task Assignment Payload Mar	lation	-
oo Tablo B) SKILL LEVEL Hrs/Dau		
MAINTENANCE torval, days turnables, kg turnables, kg turnables, kg		
Deliverables, kg Returnal	, kg	
SPECIAL CONSIDERATIONS/Soc Instructions 1) Sizes and weights can vary considerably within this general group of payloads	Thora page	
that might otherwise be placed into orbit with a PAM-A. operations. 2) Power will be self-supplied.	<u>S</u>	

GDC-ASP-83-002

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

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GDCD CODE 1101 ELEMENT NAME	MED COMMUNICATIONS SATELLITES
ACCOMODATION: 🗆 ATTACHED 🔯 FR	EF FLYER TO OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBL	Y/ATTACHMENT AND CHECKOUT)
DATE(S) 1990 INT. HRS 8	EVA HRSEVA CREW
NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVIC	ES
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME HRS PER DAY (INTERNAL) HRS PER DAY (EVA) NOT APPLICABLE 4. RECONFIGURATION INTERVAL DAYS TOTAL RECORD	
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
5. DEACTIVATION/REMOVAL	
DATE(S) INT. HRS	EVA HRS EVA CREW
NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THRO	BUGH 5 ABOVE)
	te to OTV (when available) and verify hours = 8 man hours)

TOTAL EVA HRS 0

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Code: GDCD 1101

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Medium Communications Satellite

Reference Documents:

- 1. Space Station Study, Commercial Communications Satellites, SPACECOM, Feb. 83, (GDC subcontract)
- Task II Report Planning Assistance for the 30/20 GHz Program Worldwide Market Demand Forecast, Western Union Report Sponsored by NASA, June 1981.
- 3. STS Mission Model 1983-2000, Advanced Planning Division, NASA Headquarters, Dec. 10, 1982
- 4. Mission Requirements and Network Support Forecast (STDN No. 803), Goddard Space Flight Center, Dec/Jan 1982/1983
- 5. The Satellite Communications Market in North America, 1982-1991, Frost and Sullivan, July 1981
- 6. The Market, SPACECOM Study, 4-5/1982 Presentation
- 7. Space Operations Center Systems Analysis Study Extension, Final Report, Volume I Executive Summary, By Boeing Aerospace, January 1982.
- 8. Growth and Status of Commercial Communications Satellites, NASA/LeRC, Oct. 15, 1982
- 9. A 25-Year Forecast for Commercial COMSATS and the Congestion of the Geostationary Arc, Future Systems Inc., Nov. 1977
- 10. Future of Communications Satellites, STS Users Conference, Sept. 1982, By Goddard Space Flight Center
- 11. National Space Outlook, National Space Club, June 22-23, 1982
- 12. Nominal Mission Model, Rev. 6, PSOI MSFC, 30 Sept. 1982.

Narrative:

The method used to estimate commercial communication satellite traffic is documented in Ref 1. References 2-11 contain projections made in various studies and were used as primary sources. Plots of seven principal traffic projections are in Figure 1. Figure 2 presents the two extremes and an average of Figure 1 data. Not all of these data distinguish between satellite sizes.

4. T.A Pa

Page 2 of 5 Volume II, Book 1 Appendix I

Code: GDCD 1101

PAYLOAD ELEMENT SYNTHESIS

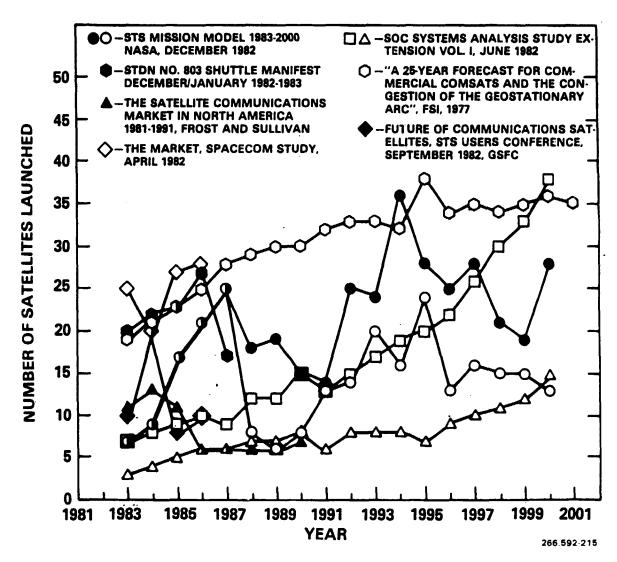
Table 1 presents traffic projections for three size classes of satellites as made by three separate sources (Ref 9, 7, 3) along with an average. The averages from Figure 2 and Table 1 are essentially equal. Ref 12 and internal analyses were used to validate satellite weights. Lengths were derived based on a modest improvement in density from current satellites. As most of the missions occur in the frame when an OTV is available, kick motors are not included. A more optimum packaging design could be forecast, which would reduce transportation costs.

Separate payload elements are defined for each payload class and identified as small, medium, and large communication satellites.

Code: GDCD 1101

PAYLOAD ELEMENT SYNTHESIS

ORIGINAL PAGE 13 OF POOR QUALITY

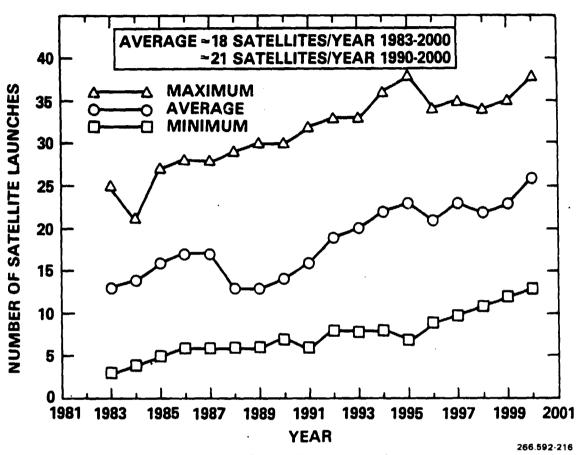


Geosynchronous Launches Reference Summary

Code: GDCD 1101

PAYLOAD ELEMENT SYNTHESIS

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Total Geosynchronous Launches

Page 5 of 5 Volume II, Book 1 Appendix I

Code: GDCD 1101

PAYLOAD ELEMENT SYNTHESIS

ORIGINAL PAGE TS OF POOR QUALITY

			MODEL A			MODEL B			MODEL C			AVG.	
	YEAR	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE
	81		-	-	5/3*	0	0	_	-	. –	4	0	0
1	82	9	8	0	3/2	0	0	- 1	_	_	5	4	0
ı	83	10	8	1	5/2	2/1	0	5	0	2	5.5	3	1
1	84	10	9	2	5/3	3/1	0	7	0	2	6	3	1
I	85	14	•	1	5/3	3/2	1	17	0	0	10	3	1
١	86	9	12	4	4/4	4/2	2/0	17	2	2	8.5	5	2
1	87	12	10	6	0/3	4/3	5/0	21	4	0	9	5	2
١	88	11	12	6	0/4	3/3	9/0	12/7	3/0	3/1	7	4	4
1	89	14	10	6	0/3	0/3	12/1	10/6	5/0	4/0	7	4	6
П	90	11	12	7	Q/2	0/5	15/1	10/5	3/2	2/1	-6-	4	5
ij	91	11	12	9	0	0/5	13/1	9/9	3/1	2/3	6	4	6
!]	92	10	13	10	0	0/5	15/3	20/10	3/2	2/2	8	6	6
!	93	13	11	9	0	0/5	17/3	22/13	1/4	1/3	10	4	7
9	94	11	10	11	0	0/1	19/7	26/14	0	10/2	10	3	10
H	95	11	16	11	0	0	20/7	17/21	3/0	8/3	10	4	10
	96	8	13	13	0	0	22/9	12/6	3/0	10/7	5	3	12
!]	97	9	13	13	0	0	26/10	17/11	0	11/5	7] 3	13
!	98	11	11	12	0	0	30/11	12/9	0	9/6	6	3	14
IJ	99	8	13	14	0	0	33/12	14/10	0	5/6	6	3	14
Ц	00	6	13	17		lo	38/15	17/10	O	11/3		3	17_
7	01		13	14				T				12	14
1	02	7	13	18	I -	-	_	- 1	-	-	7	13 12	18
L	υZ		14				_				<u></u>	12	18

SMALL UP TO 1800 lbs. (RCA SATCOMHUGHES 376 CLASS)
MEDIUM 1900-4500 lbs. (FORD INTELSAT V CLASS)
LARGE 5100 lbs. + (TDRSS CLASS)

*HIGH/LOW MODEL

266.592-217

Satellite Launch Prediction by Mass

ORIGINAL PAGE 19 OF POOR QUALITY

		Page 1 of 3
	CODE	TYPE
Large Communication Satellite	6 0 c 0 1 1 0 2	
W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division		Applications (non-commercial)
Hadross P.O. Box 85357 San Diego, CA 92138		X Commercia!
Telephone (619) 277-8900, Ext. 3778/2130		Technology
784		Operations
U hpproved Opportunity	unity	Type Number
		(see Table A)
No. of flights 114 12 12 12 12 12 12 12 12 12 12 12 12 12		Importance of the Space Station to
į		
Transfer payload from Shuttle, mate it to OTV for transfer to GEO.	for transfer to	•
		10 - vital
		Scale 1 - 10 5.
DESCRIPTION		
Space Station will provide an economic benefi Space Station by Shuttle. Antennas/appendage	t. Large satellites s will be deployed t	provide an economic benefit. Large satellites will be delivered to the uttle. Antennas/appendages will be deployed there. These payloads (1 or
2) will then be mated to an OTV if available. Payload checkout will be performed to boost and injection into GEO. Number of flights is based on a range of 5 to 17 flights per year through 2000.	Payload checkout w based on a range of	checkout will be performed to boost a range of 5 to 17 flights per year

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(m	OF P	OOR QUALITY
CODE 6 D C D 1 1 0 2	min min	rics rnal Remote surized Unpressurized U, m 4.5 K, m kg kg	CREU REQUIREMENTS Skills (See Table B) Skills (Skills B) Skills (See Table B) Skills (See Table B) Skills (Skills B) Skills (See Table B) Skills (Skills

GDC-ASP-83-002

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 1102 ELEMENT NAME LAR	GE COMMUNICATIONS SATELLITES
ACCOMODATION: ATTACHED & FREE FLY	ER 🖸 OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATT	ACHMENT AND CHECKOUT)
DATE(S) 1990 INT. HRS 12 EVA	HRSEVA CREW
□ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR I	MONITOR, INSPECT, ETC.)
HRS PER DAY (EVA)	
☑ NOT APPLICABLE	•
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONFIGS.	
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	•
DATE(S) INT. HRS. EVA	IRS EVA CREW
NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	ABOVE)
1. Task is to transfer satellite to mating operations (3 men x 4 hou	

TOTAL EVA HRS ____

9

Page 1 of 5 Volume II, Book 1 Appendix I

Code: GDCD 1102

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Large Communications Satellite

Reference Documents:

- Space Station Study, Commercial Communications Satellites, SPACECOM, Feb. 83. (GDC subcontract)
- 2. Tas: II Report Planning Assistance for the 30/20 GHz Program Worldwide Man et Demand Forecast, Western Union Report Sponsored by NASA, June 1981.
- 3. STS Mission Model 1983-2000, Advanced Planning Division, NASA Headquarters, Dec. 10, 1982
- 4. Mission Requirements and Network Support Forecast (STDN No. 803), Goddard Space Flight Center, Dec/Jan 1982/1983
- 5. The Satellite Communications Market in North America, 1982-1991, Frost and Sullivan, July 1981
- 6. The Market, SPACECOM Study, 4-5/1982 Presentation
- 7. Space Operations Center Systems Analysis Study Extension, Final Report, Volume I Executive Summary, By Boeing Aerospace, January 1982.
- Growth and Status of Commercial Communications Satellites, NASA/LeRC, Oct. 15, 1982
- 9. A 25-Year Forecast for Commercial COMSATS and the Congestion of the Geostationary Arc, Future Systems Inc., Nov. 1977
- 10. Future of Communications Satellites, STS Users Conference, Sept. 1982, By Goddard Space Flight Center
- 11. National Space Outlook, National Space Club, June 22-23, 1982
- 12. Nominal Mission Model, Rev. 6, PSO1 MSFC, 30 Sept. 1982.

Narrative:

The method used to estimate commercial communication satellite traffic is documented in Ref 1. References 2-11 contain projections made in various studies and were used as primary sources. Plots of seven principal traffic projections are in Figure 1. Figure 2 presents the two extremes and an average of Figure 1 data. Not all of these data distinguish between satellite sizes.

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Page 2 of 5 Volume II, Book 1 Appendix I

Code: GDCD 1102

PAYLOAD ELEMENT SYNTHESIS

Table 1 presents traffic projections for three size classes of satellites as made by three separate sources (Ref 9, 7, 3) along with an average. The averages from Figure 2 and Table 1 are essentially equal. Ref 12 and internal analyses were used to validate satellite weights. Lengths were derived based on a modest improvement in density from current satellites. As most of the missions occur in the frame when an OTV is available, kick motors are not included. A more optimum packaging design could be forecast, which would reduce transportation costs.

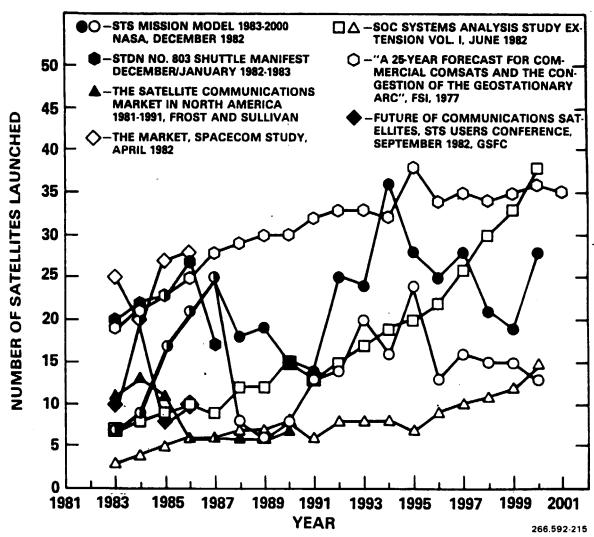
Separate payload elements are defined for each payload class and identified as small, medium, and large communication satellites.

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PAYLOAD ELEMENT SYNTHESIS

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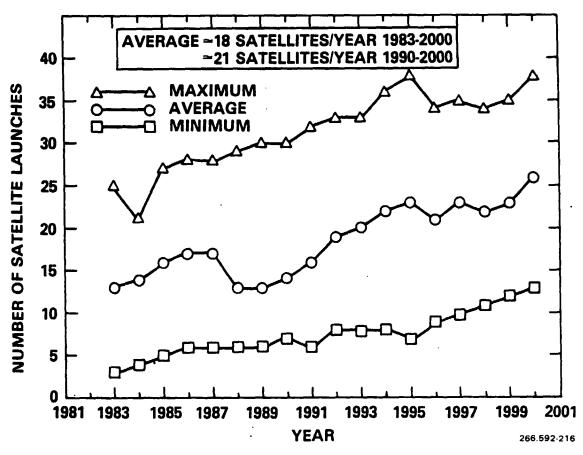


Geosynchronous Launches Reference Summary

Code: GDCD 1102

PAYLOAD ELEMENT SYNTHESIS

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Total Geosynchronous Launches

Page 5 of 5 Volume II, Book 1 Appendix I

Code: GDCD 1102

PAYLOAD ELEMENT SYNTHESIS

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		MODEL A			MODEL B			MODEL C	-		AVG.	
YEAR	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE
81	_	_	_	5/3*	0	0	-	-	-	4	0	0
82	9	8	0	3/2	0	0	_	_	-	5	4	0
83	10	8	1	5/2	2/1	0	5	0	2	5.5	3	1
84	10	9	2	5/3	3/1	0	7	0	2	6	3	1
85	14	8	1	5/3	3/2	1	17	0	0	10	3	1
86	9	12	4	4/4	4/2	2/0	17	2	2	8.5	5	2
87	12	10	6	0/3	4/3	5/0	21	4	0	9	5	2
88	11	12	6	0/4	3/3	9/0	12/7	3/0	3/1	7	4	4
89	14	10	6	0/3	0/3	12/1	10/6	5/0	4/0	7	4	6
90	717	12	7	Q/2	0/5	15/1	10/5	3/2	2/1	6	4	5
91	11	12	9	0	0/5	13/1	9/9	3/1	2/3	6	4	6
92	10	13	10	0	0/5	15/3	20/10	3/2	2/2	8	6	6
93	13	11	9	0	0/5	17/3	22/13	1/4	1/3	10	4	7
94	11	10	11	0	0/1	19/7	26/14	0	10/2	10	3	10
95	11	16	11	0	0	20/7	17/21	3/0	8/3	10	4	10
96		13	13	١٠	0	22/9	12/6	3/0	10/7	5	3	12
97	9	13	13	lo	lo	26/10	17/11	0	11/5	7	3	13
98	11	11	12	i o	1 0	30/11	12/9	0	9/6	6	3	14
99	8	13	14	0	0	33/12	14/10	0	5/6	6	3	14
00	6	13	17	0	0	38/15	17/10	0	11/3	<u> </u>	3	<u> </u>
01	8	13	14		_	l _		1 _	l _	8	13	14
02	7	12	18	-	-	-	_	_	_	7	12	18

SMALL UP TO 1800 lbs. (RCA SATCOMHUGHES 376 CLASS)
MEDIUM 1900-4500 lbs. (FORD INTELSAT V CLASS)
LARGE 5100 lbs. + (TDRSS CLASS)

*HIGH/LOW MODEL

Satellite Launch Prediction by Mass

256.592-217

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	Page 1 of 3
PAYLOAD ELEMENT NAME Experimental GEO Platform G D C D 1 1 0 3	TVPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Name General Dynamics Convair Division	Applications (non-commercial)
Telephone (619) 277-8900, Ext. 3778/2130	Technology
STATUS STATUS Descriptional XPlanned	Operations
	Type Number
First flight, yr 1990 No. of flights 1 Duration of Flight, days 5 OBJECTIVE	Importance of the Space Station to this Element
Remove the platform from Shuttle and mate it to the OTV. Deploy antennas and other appendages as necessary. Perform an integrated checkout and the boost to GEO for deployment.	
	Scale 1 - 10 8
DESCRIPTION The experimental GEO platform will be a multi-use platform with its principle function be communication. Some science and applications will also be included. It will be brought the Space Station by Shuttle where it will be made ready for transfer to GEO. It will be mated to an OTV when antennas and other appendages will be deployed. After a complete che out it will be boosted at low "g" to GEO. Reference MSFC mission model Rev. 6, 9-30-82.	platform will be a multi-use platform with its principle function being science and applications will also be included. It will be brought to Shuttle where it will be made ready for transfer to GEO. It will be antennas and other appendages will be deployed. After a complete checkdat low "g" to GEO. Reference MSFC mission model Rev. 6, 9-30-82.
ورودين والبروا ووالي والمراوات والمراوات والمراوات والمراوات والمراوات والمراوات والمراوات والمراوات	

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C					
CODE 6.0.01.1.0.3 Page 2 of 3	Periges, km 35.786 Tolerance + Colerance + Ephemeris Accuracy, m	FATION FATION Incrtial Solar Earth known; scy,arc sec Field of view, deg ity (Jitter)arc sec/sec ity (Jitter)arc sec/sec ity (Jitter)arc sec/sec		ants: (During altime Oof yption Requir mand Rate (Ki rocessing Req	37254
	ORBIT CHARACTERISTICS Apogee, km 35,786 Period Inclination, deg Condal Angle, deg	POINTING/ORIENTATIC Ulow direction Truth Sites (1f kno Pointing accuracy, a Pointing Stability Special Restriction	JAC Operating Standby Peak	MUNICATIC ng requir yption/De nk Req.: cerd Data ription Iype and Ra	Gunt) (Hrs/ Stor P Fre

ORIGINAL PACE 13 OF POOR QUALITY

E		T			П			Γ.	÷
3 Page 3 of		Stowed Deployed	1) Payload Manipulation 2) Checkout		15		ka		schedule is met be self-supplied 3 Hrs/Day for
6 0 c 0 1 1 0 3	X	ad 4.5 5,450	Payload Manipula		Hra/FUA	.1	- Man/Hrs Rog Returnables.		1992. If the . 2) Power will wof one working available.
		X Remote 4.5 H,m H,m 5,101tu, a min	ont	3 2	Deployment Assist	Consummables,		5	isit scheduled in not be available. EVA based on crew sing OTV/TMS, if
	Passive operational min- non-operational min- operational min-	rics rnal surized U, m U, m kg Types	Task A	SKILL LEVEL	H. s/Day Renson Deploy	g	Interval, day	IONS/500 Instructions	mission. There is a revisit scheduled in 1992. If the schedule is me tion/OTV capability will not be available. 2) Power will be self-supplitime only for 5 days. 4) EVA based on crew of one working 3 Hrs/Day for ervicing revisit at GEO using OTV/TMS, if available.
	ີ ລີ 3	PHYSICAL CHARACTERIST Internal Extention ID/Function 10 Prest L,m 410 L,m 410 L,m 410 Consumables Consumables	EMENTS 2	Table B)	2	INTENANCE broal, days		CONSIDERATIONS/Se	0 6 6 7
	THERMAL []Active Temperature, deg	EQUIPMENT PH Location: Equipment II	CREU REQUIREMENTS Craw Siza	Skills (See	EUA 🗵 YES	SERVICING/MAINTENANCE SERVICE:Interval, day Returnables.	CONFIGURATION	SPECIAL CONS	1) This is a one-time (1990), the Space St. 3) Crew required one 5 days. 5) Unmanned

GDC-ASP-83-002

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE	1103		ELEMENT N	AME EXPE	RIMENTAL	GEO PLAT	FORM
ACCOMODA	TION:	ATTAC	HED 🛛	FREE FLY	R 🔼 0	TV OPS	
1. STATION	ACTIVATI	ON (E.G., S	ET-UP/ASSE	M8LY/ATTA	CHMENT AN	ID CHECKOUT)	
DATE(S)	1990	INT. H	RS 40	EVA i	irs 15	EVA CRI	EW
							
☐ NO	T APPLICA	BLE					
2. SERVICE	(E.G., REP	LENISH/RE	SUPPLY)				
INTERVA	AL 730	DAYS	TOTAL SER	VICES			
☑ TM	S/OTV RED	LUIRED			STATION H	IRS PER SERVI	CE
□ NO	T APPLICA	BLE			EVA HRS P	PER SERVICE	
					EVA CREW	SIZE	
3. STATION	OPERATIO	DNAL SUPP	ORT (AVG.	TIME FOR M	ONITOR, INS	SPECT, ETC.)	
	HRS PER						
	 HRS PER	B DAY (EVA	()				
	T APPLICA						
4 850045							
4. RECONFI			TOTAL DE	CONFICE			
_			TOTAL RE	CONFIGS.		00 050 05000	510
_	S/OTV REQ						FIG.
ι <u>Σ</u> Ι ΝΟ	T APPLICAI	BLE				ER RECONFIG.	
					EVA CREW	SIZE	
5. DEACTIV	ATION/RE	MOVAL					
DATE(S)		INT. H	RS	EVA H	RS	EVA CREW	
							
⊠ NO¹	T APPLICA	BLE					
6. NOTES (E	RIEFLY DI	ESCRIBE TA	asks in 1 T	HROUGH 5 A	(BOVE)		
Int 5 d EVA	ernal h ays for is bas	ours ba a tota ed on 1	sed on c l of 40 man 3 h	hours. ours/day		lays	ours/day for

TOTAL EVA HRS 15

3

Page 1 of 1 Volume II, Book 1 Appendix I

Code: GDCD 1103

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Experimental GEO Platform

Reference Documents:

1. Nominal Mission Model, Rev. 6, MSFC PSC1, 30 Sept 1982

Narrative:

The detailed description of this payload was obtained from prior GDC studies. The experimental GEO platform will be a satellite of about 10-12k lb. Consisting of mostly communications (85%) and some multidiscipline experiments (15%). It will be carried by the Shuttle to LEO, where antennas and other appendages will be deployed before it is transferred to GEO (at low thrust) by the OTV.

Ref 1 shows the launch as taking place in 1989; more realistically it will be at least 1990 before the mission is accomplished.

Although listed as a commercial P/L element in accordance with LaRC payload-categorization, this is a NASA provided payload element, per Ref 1.

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PAYLOAD ELEMENT NAME Operational GEO Platform Operational GEO Platform	TYPE TYPE
W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division	
Hddross P.O. Box 85357 San Diego, CA 92138	X Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Technology Development
STATUS STATUS Nonet Specifications Statement S	Operations
- Candidate Opportunity	Tupe Number
First flight, yr 1994 No. of flights 11 Duration of Flight, days 5	(see Table A) Importance of the Space Station to this Element
The objective is to construct 2 space platforms over a period of time. One will consist of 5 modules and the other 6, each module the size of the experimental GEO platform. These modules 10	-0.
will be delivered by Shuttle to the Space Station and them attached to the OTV for transfer to GEO.	Scale 1 - 10 8
DESCRIPTION The operational GEO platform will consist of multiple modules, each roughly the size/weight of the experimental GEO platform. The modules will be carried to LEO by the Shuttle, attach to an OTV, and transferred to GEO for assembly and checkout. An alternate method will be to assemble the modules in LEO, checkout the platform, and then use multiple OTVs to lift the platform to GEO. Reference MSFC mission model Rev. 6, 9-30-82.	consist of multiple modules, each roughly the size/weight The modules will be carried to LEO by the Shuttle, attached for assembly and checkout. An alternate method will be to out the platform, and then use multiple OTVs to lift the ission model Rev. 6, 9-30-82.

m	1	<i>f</i>			
CODE GD CD 11 0 4		OINTING/ORIENTATION direction Sites (if k ointing accuracy ointing Stability	JAC Operating Standby Peak	MUNICATIONS ng requirements: Realtime	STORE BYORE

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3 0 5			<u>p</u>					t crew S,.
0 4 Page 3 of		Stowed Deployed	Platform Checkout and Monitoring		09	8. kg	ł	in 1995. Eigh 2) Physical ch 4 is based on 7icing revisit
CODE 6 0 C 0 1 1 0 4	X X X X X 8 8 8 8 8 8 8 8	0.0	form Checkout		Hrs/EUA	kg Man/Hrs Roq. Returnables.		r operation. 3 eckout. 4) EV/ otal of 8 serv
		Remote Unpressurized 4.5 H, m H, m 5450	1 1	2 4	Construction	Consummbles, Man Hours		1) Assembly of modules will start in 1992, with revisits scheduled to start in 1995. Eight revisits are scheduled. Crew required twice per year, 5 days per operation. 2) Physical characteristics are per module. 3) Power is self-supplied during checkout. 4) EVA is based on crew of 2 working 6 Hrs/Day for 5 days for each of 11 flights. 5) Total of 8 servicing revisits,
	onel min onel min onel min	TICS surixed U,m U,m Xg Yges	1 - 1	Day.	Ranson Space Cons	day les, kg.	structions	n 1992, with r ed twice per y r is self-supp or each of 11
	Passive operational non-operational non-operational non-operational	ARACT Inch a	1 (2711)		ONO Reas	rkg Int	TIONS/Sam Instructions	will start in Crew requiredule. 3) Power for 5 days for
	် 3	PHYSICAL ID/Functi	IREMENTS Table			SERVICING/MAINTENANCE SERVICE: Interval, day Returnables, CONFIGURATION CHANGES	SPECIAL CONSIDERATI	1) Assembly of modules revisits are scheduled. acteristics are per mod of 2 working 6 Hrs/Day
	THERMAL GACTIVE Temperature, deg	EQUIPMENT Location: Equipment	CREW REQU		EUA X YES	SERUICING SERUICE: I CONFIGURA	SPECIAL C	1) Assemb revisits acteristi of 2 work

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PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 1104 ELEMENT NAME OF	PERATIONAL GEO PLATFORM
ACCOMODATION: ATTACHED THE FREE F	LYER 🖸 OTV OPS .
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/AT	TTACHMENT AND CHECKOUT)
DATE(S) 1994 INT. HRS 20 EV	VA HRS 60 EVA CREW 2
NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY) VARIABLE INTERVAL DAYS TOTAL SERVICES V	ARIABLE
TMS/OTV REQUIRED	STATION HRS PER SERVICE
□ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR	R MONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
☐ NOT APPLICABLE	•
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONFIG	s
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(3) INT. HRS EV/	A HRS EVA CREW
■ NOT APPLICABLE	

- 6. NOTES (PRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)
- Internal hours based on 4 hours/day for 5 days
 EVA hours based on crew of 2 working hours/day for 5 days
 One service/revisit every year 1995 a J on through 2000.
 2 revisits planned in 1997 and 2000 (8 total)

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Code: GDCD 1104

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Operational GEO Platform

Reference Documents:

1. Nominal Mission Model, Rev. 6, MSFC PS01, 30 Sept. 1982

Narrative:

The detailed description of these payloads was obtained from prior GDC studies. There will be two platforms, one consisting of five modules and the other six modules. Each module will require an OTV flight to GEO, where it will be mated with the other modules. Each module will be roughly the size and weight of the experimental GEO platform.

Although listed as a commercial payload element in accordance with LaRC payload categorization; the first two platform modules will be provided as NASA payload elements per Ref 1.

ORIGINAL PAGE TO OF POOR QUALITY

			Page 1 of
PAYLOAD ELEMENT Large Deployable A	NAME ntenna	CODE G D C D 1 1 O 6	•
CONTACT	Peterson MZ 21-9530 namics Convair Division	•	Applications (non-commercial)
	P.U. Box 85357 San Diego, CA 92138		X Commercial
Telephone	(619) 277-8900, Ext. 3778/2130		Technology
STATUS			3 HD H () B > 6 A
	nal	þe	Operations
LAP.	_Approved X Candidate	date tunitu	New 7
First fli		3	(see Table A)
No. of fl			
Duration	Duration of Flight, days 14		Space Station to
OBJECTIVE	1) Develop the technology for deploying large		this Elegant
(>15 m diam	(>15 m diameter) communications satellite antennas and	Ė	
ted feeds;	ted feeds; 2) demonstrate new deployment techniques; 3) meas-	niques; 3) meas-	1 - low value but
ure static	ure static and dynamic mechanical properties, including	including surface	
accuracy; 4	accuracy; 4) determine effects of the space environment	nvironment on an-	16 - vital
tenna structure; and	cture; and 5) measure electrical performance.	rformance.	
			Scale 1 - 10 9
DESCRIPTION	IN A variety of configurations and a large range of experimental parameters	nd a large range of	experimental parameters and
activities	activities may be proposed. Reflectors, horns, arrays, lenses, and other types of antennas	, arrays, lenses, ar	nd other types of antennas
may be considered.	idered. The erectable antennas may	have deployed dimer	The erectable antennas may have deployed dimensions from 15 to 100 m. They
may be unto	may be untolded, unrolled, intlated, extended, or assembled trom separately launched components Reflectors horns and other large antennas that require precise mechanical tolerances will need	, or assembled trom at require precise m	separately launched components.
a large num	a large number of measurements to determine the mechanical performances in space; whereas	he mechanical perfor	mances in space; whereas
arrays or c	arrays or antennas that can be tuned, adapted, and controlled electrically may not need elab-	, and controlled ele	ectrically may not need elab-
orate measu Second flic	orate measurements of the mechanical performances. Second flight in 1994. Payload could be classified	nces. ified as technology development.	development.

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C		OF POOR	t dover .		
6.0 C. 0.1.1.0.6 Page 2 of	•	20	Continuous	Frequency (MHZ)	Experiment Dependent
2 0 9 9 0 0	Apogoe, km Any Periges, km Any Tolerance + Inclination, deg Any Tolerance + Nodel Angle, deg Escape dV Required, m/s	OINTING/ORIENTATION direction ruth Sites (if kerting accuracy ointing Stabilities (in the control of the contro	OUER Standby 300 SO Peak of tage, U	IMUNICATIONS Ing requirements: Ing requirements: Whtion/Decryption Required Ink Req.: Command Rate (KBS) ioard Data Processing Required Intion Intion Intion Interpretable test results data rate of 200 - 400 kbps.	Gal Ount) (Hrs/ Stor P Fre

•	·	OF	POOR	PAG QUA			
9 (Stowed Deployed			40		DECIAL CONSIDERATIONS/Soc Instructions A stowed antenna will be carried to the SS via Shuttle. It will be placed in an external location such that when deployment actuation via astronaut command from SS is made, the antenna will point toward the earth. When the experiments are completed, the antenna should be refolded and returned to Earth on a Shuttle or put into a controlled reentry orbit.
CODE G.D.C.D.1.1.06	X X X X X X X X X X X X X X X X X X X	3 50	Y DE		Hrs/FUA	kg Man/Hrs Roq. Returnables	DECIAL CONSIDERATIONS/Soo Instructions A stowed antenna will be carried to the SS via Shuttle. It will be placed in an external l tion such that when deployment actuation via astronaut command from SS is made, the antenna will point toward the earth. When the experiments are completed, the antenna should be refed and returned to Earth on a Shuttle or put into a controlled reentry orbit.
<u>3</u>		اختا	nmont	3		163,	ied to the SS via Shuttle. It will be placed in actuation via astronaut command from SS is mad When the experiments are completed, the antenna Shuttle or put into a controlled reentry orbit.
	Nat min hat min hat min	TICS surized Remotes Wind Surized Wind Suriz	Task Assignment		onst/Measu	Cons day Man	uctions SS via Shutt On via astrona experiments a
·	X Passive operational non-operational operational non-operational	18.00 () E C C C C C C C C C C C C C C C C C C		SKILL		kg Interval, day Deliverables,	N S/See Instr e carried to the loyment actuatic arth. When the hon a Shuttle c
	≝ວ້ ີ	PHYSICAL CHA X Internal ID/Function L,m L,m Con	1 1	Table B)	ON D	arntenance broal, days urnablos, k on changes	PECIAL CONSIDERATIONS/S A stowed antenna will be carr tion such that when deploymer will point toward the earth. ed and returned to Earth on a
	THERMAL []Activo Temperaturo, deg Heat Rejection, w	EQUIPMENT P Location: Equipment I	CREU REQUIREMENTS Craw Siza	Skills (See Table	EUA 🗵 YES	SERVICING/MAINTENANCE SERVICE:Interval, days Returnables, kg CONFIGURATION CHANGES:Interval,	SPECIAL CONSIDERATIONS/Soo Instructions A stowed antenna will be carried to the SS via S tion such that when deployment actuation via ast will point toward the earth. When the experimen ed and returned to Earth on a Shuttle or put int

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GOCD CODE 1106	ELEI	MENT NAME	LARGE DI	PLOYAB	LE ANTENNA	
ACCOMODATION:	X ATTACHED	☐ FRE	E FLYER	□ 0TV	OPS	
1. STATION ACTIVAT	FION (E.G., SET-U	IP/ASSEMBLY	/ATTACHM	ENT AND	CHECKOUT)	
DATE(S) 1992	INT. HRS	5	EVA HRS_	10	EVA CREW	2
1994		3	_	10		2
NOT APPLIC	ABLE					
2. SERVICE (E.G., RE	PLENISH/RESUP	PLY)				
INTERVAL	_DAYS, TOT	AL SERVICE	s			
TMS/OTV RE	QUIRED		STA	ATION HRS	PER SERVICE	
■ NOT APPLIC	ABLE		EV	A HRS PER	SERVICE	
			EV	A CREW SI	ZE	
3. STATION OPERAT	IONAL SUPPORT	(AVG. TIME	FOR MONIT	OR, INSPE	CT, ETC.)	
.5 HRS PE	ER DAY (INTERN	AL)				
HRS PE						
☐ NOT APPLICA	ABLE					
4. RECONFIGURATIO)N					
INTERVAL	_DAYS TO	TAL RECON	FIGS			
☐ TMS/OTV RE	QUIRED		STA	TION HRS	PER RECONFIC	3
M NOT APPLICA	ABLE		EVA	HRS PER	RECONFIG.	
			EVA	CREW SIZ	Œ.	
5. DEACTIVATION/R	EMOVAL					
DATE(S) 1992			EVA HRS	10	EVA CREW	2
1994				10		2
□ NOT APPLICA					_	
6. NOTES (BRIEFLY	DESCRIBE TASKS	S IN 1 THROU	IGH 5 ABOV	E)		
OP support monitoring	for construct t req. for 2 g (28 days t earth retur	2 periods total)	ist and of 14 o	surfac days ea	e measurem ch for per	ent. formance

Code: GDCD 1106

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Large Deployable Antenna

Reference Documents:

Supplied by SPACECOM under subcontract to GDC

Narrative:

The Space Station would provide the "bus" housing and support for the undeployed antenna brought to orbit by the shuttle. The antenna would be placed on the station where it could be observed during the deployment sequence. If communications experiments are to be conducted with the antenna, such as RFI, then the station would provide electrical power, a stable platform, and a location for the RF equipment.

The astronauts would have the responsibility to set up the experiment, position the antenna on the station, photograph the antenna deployment, perform the surface accuracy measurements employing RF or laser scanning techniques and conduct communications or RFI measurements with the antenna. When the antenna experiment is completed, the astronaut is to cut the antenna from the station or refurl the antenna for return to earth via the shuttle.

wrements W Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division P.O. Box 85357 San Diego, CA 92138 Perational Ilght, yr 1994 Ilght, yr 1994 Itlghts 1			Page 1 of
RFI Measurements CONTROL Weardy/J. Peterson MZ 21-9530 Rddrass Posson Radrass Pan By San Diego, CA 92138 Scandidate Tocharaction Tocharactoric and identify a single source of known RF trans-from the space allocated bands, and demonstrate the ability to lotated bands, and demonstrate the ability to lotate (*15 m diameter), earth-pointing antenna having a "zoom" capability to receive RF signals from Earth. A calibrated spectrum analy is then used to determine frequency, power level and spectral characteristics of the rece signal. Several different antenna feeds and receiving equipments are required to characte the RF. First Flight 1994 with full time unit operational in approximately 6 years.	PAYLOAD ELEMENT NAME	CODE	
CONTACT W Hardy/J. Peterson MZ 21-9530 Addrass Addrass Addrass Addrass Addrass Addrass Cemmercial San Diego, CA 92138 Telephone (619) 277-8900, Ext. 3778/2130 STATUS Choperational Approved Chight, Ur 1994 No. of filght, Ur 1994 No. of filght, Ur 1994 To characterize and identify a single source of known RF trans- mission (from 100 MHz and higher) originating from the Earth in the space allocated bands, and demonstrate the ability to 10- DESCRIPTION Employ a low-noise receiver connected to a large (>15 m diameter), earth-pointing antenna having a "zoom" capability to receive RF signals from Earth. A calibrated spectrum analy is then used to determine frequency, power level and spectral characteristics of the rece signal. Several different antenna feeds and receiving equipments are required to characte the RF. First flight 1994 with full time unit operational in approximately 6 years.		6 D C D 1 1 U /	
Telephone (619) 277-8900, Ext. 3778/2130 Telephone (619) 277-8900, Ext. 3778/2130 STATUS Condidate Candidate Cardidate First flight, yr 1994 No. of flight, days Duration of Flight, days Cate (within 5 km) such transmissions. Employ a low-noise receiver connected to a large (>15 m diameter), earth-pointing antenna having a "zoom" capability to receive RF signals from Earth. A calibrated spectrum analy is then used to determine frequency, power level and spectral characteristics of the receiver tile RFI. First flight 1994 with full time unit operational in approximately 6 years.	W Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division		Applications (non-commercial)
Telephone (619) 277-8900, Ext. 3778/2130 STATUS Cloperational C			X Commercial
First filghts Scandidate Opportunity Type Number Type Number Candidate Opportunity Type Number Type Number Candidate Opportunity Type Number Type			O Technology
First flight, yr 1994 First flight, yr 1994 Copportunity First flight, yr 1994 No. of flight, days Duration of Flight, days OBJECTIVE To characterize and identify a single source of known RF trans- mission (from 100 MHz and higher) originating from the Earth in the space allocated bands, and demonstrate the ability to 10- cate (within 5 km) such transmissions. DESCRIPTION Employ a low-noise receiver connected to a large (>15 m diameter), earth-pointing antenna having a "zoom" capability to receive RF signals from Earth. A calibrated spectrum analy is then used to determine frequency, power level and spectral characteristics of the recessignal. Several different antenna feeds and receiving equipments are required to characte the RFI. First flight 1994 with full time unit operational in approximately 6 years.			
First flight, yr 1994 No. of flights 1 Duration of Flight, days 21 Duration of Flight, days 21 OBJECTIVE To characterize and identify a single source of known RF trans- mission (from 100 MHz and higher) originating from the Earth in could use the space allocated bands, and demonstrate the ability to loginating from the Earth in the space allocated bands, and demonstrate the ability to loginating from the Earth in such transmissions. DESCRIPTION Employ a low-noise receiver connected to a large (>15 m diameter), earth-pointing antenna having a "zoom" capability to receive RF signals from Earth. A calibrated spectrum analy is then used to determine frequency, power level and spectral characteristics of the recessional. Several different antenna feeds and receiving equipments are required to characte the RFI. First flight 1994 with full time unit operational in approximately 6 years.		d Bto Unitu	
To characterize and identify a single source of known RF trans- mission (from 100 MHz and higher) originating from the Earth in the space allocated bands, and demonstrate the ability to lo- cate (within 5 km) such transmissions. DESCRIPTION Employ a low-noise receiver connected to a large (>15 m diameter), earth-pointing antenna having a "zoom" capability to receive RF signals from Earth. A calibrated spectrum analy is then used to determine frequency, power level and spectral characteristics of the recessignal. Several different antenna feeds and receiving equipments are required to characte the RFI. First flight 1994 with full time unit operational in approximately 6 years.	1994 1 t, days		
Employ a low-noise receiver connected to a large (>15 m diameter), earth-pointing antenna having a "zoom" capability to receive RF signals from Earth. A calibrated spectrum analy is then used to determine frequency, power level and spectral characteristics of the recessignal. Several different antenna feeds and receiving equipments are required to characte the RFI. First flight 1994 with full time unit operational in approximately 6 years.	To characterize and identify a single source of mission (from 100 MHz and higher) originating the space allocated bands, and demonstrate the cate (within 5 km) such transmissions.		1 = low value but could use 10 = vital
DESCRIPTION Employ a low-noise receiver connected to a large (>15 m diameter), earth-pointing antenna having a "zoom" capability to receive RF signals from Earth. A calibrated spectrum analy is then used to determine frequency, power level and spectral characteristics of the recesignal. Several different antenna feeds and receiving equipments are required to characte the RFI. First flight 1994 with full time unit operational in approximately 6 years.			Scale 1 - 10
	DESCRIPTION Employ a low-noise receiver connected to a lar having a "zoom" capability to receive RF signs is then used to determine frequency, power lev signal. Several different antenna feeds and re the RFI. First flight 1994 with full time unit operation	rge (>15 m diameter) als from Earth. A c el and spectral cha eceiving equipments onal in approximatel	er), earth-pointing antenna A calibrated spectrum analyzer characteristics of the received its are required to characterize ately 6 years.

G D C D 1 1 0 7 Page 2 of 3	Any Periges, km Any Tolerance + deg Any Tolerance + deg Any Tolerance + Ephemeris Accuracy, m	DRIENTATION ction Incrtial Solar Earth ss (if known) in continental U.S. sccuracy, arc sec 3600 Field of view, deg Near Hemispherical stability (Jitter) arc sec/sec	XDC Power, U Duration, hrs/day 100 Power, U Duration, hrs/day 25 300 XContinuous Frequency, Hz	ONS rements: Realtime Of Realtime Of Command Rate (K Com
	ORBIT CHARACTERIST Appropriate Notes and Angle, deg Nodel Angle, deg Escape do Requires	ENTA ON OLF UTBC TICT	POWER Operating Standby Peak	MUNICATI ng requi uption/D nk Req. t oard Date (Amount TU (Hrs.

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6.0 C.0.1 1.0.7 Page 3 of		Stowed	ng		4	-	Roq.	Í
CODE			Monitoring		7137	les, kg		
	#1# #1# #1#	Remote Vibrassu H,	ent	3	ee o	Cons		ons s may be sensi
·	ational a ational a ational a	17 25 1 1 -	Task	SKILL LEVEL	Hrs/Day Change	SERVICE Interval, days	broat, day	ECIAL CONSIDERATIONS/Soc Instructions RFI monitoring over certain foreign countries may be sensitive.
,	Fed D	CHARAC Ion L, m L, m Launch Consum Accele	łi	ble B)	<u> </u>	TENANCE al, days	ables, kg CHANGES:Inte Deli	ERATIONS/Soc ver certain fo
	THERMAL MActive Temperature, deg Heat Rejection,	EQUIPMENT PHYSICAL Location: X Interequipment ID/Funct	J REQUIREMENTS	Skills (See Table	ע ב	JICING/MAIN	Return Iguration	IAL CONSID
	THE!	E 9 4	CREU	Skı	FUA	SERI	CONF	SPE(

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1107 ELEMENT NAME R	FI MEASUREMENTS
ACCOMODATION:	ER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	ACHMENT AND CHECKOUT)
DATE(S) 1994 INT. HRSEVA	HRSEVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR M	IONITOR, INSPECT, ETC.)
0.5 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	,
☐ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL 7 DAYS TOTAL RECONFIGS.	2
TMS/OTV REQUIRED	STATION HRS PER RECONFIG. 2
☐ NOT APPLICABLE	EVA HRS PER RECONFIG. 2
	EVA CREW SIZE1
5. DEACTIVATION/REMOVAL	
DATE(S) 1994 INT. HRS EVA H	IDC EVA COCIN
DATE(S) INT. And EVA A	
□ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 /	A POVE)
	700 V C7
 Station OPS Continuous monitoring for 21 days 	.
4. Change feeds5. Station OPS	

Code: GDCD 1107

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: RFI Measurements

Reference Documents:

Supplied by SPACECOM under subcontract to GDC

Narrative:

A need exists to be able to detect and measure the signal strength of terrestrial-based radio emissions operating out of band or transmitting higher than permitted signal levels. The FCC attempts to monitor these emmissions by ground-based vehicles. A low-altitude satellite containing a sensitive receiver and high G/T antenna should be capable of detecting sources of terrestrial transmissions in frequency bands of interest, determine its spectral signature and antenna pattern and locate the source (to a few kilometers). To accomplish this experimental test, a large antenna having a "zoom" capability to narrow its beam coverage will be required, plus a low noise receiver and a spectrum analyzer. The antenna should have a capability to operate within a frequency range from 100 MHz to 30 GHz.

A scientist-astronaut on the Space Station can aid this experiment by setting up the antenna, change feeds when required, operate the zoom feature of the antenna, observe the spectral data, and verify the interfering source's location on the earth.

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			Page 1 of
PAYLOAD ELEMENT	EMENT NAME	CODE	TYPE
Laser Communications	nications	6 0 C 0 1 1 0 8	1 4744178
CONTACT	M. Hardy/J. Peterson MZ 21-9530		Applications
Addross	General Dynamics Convair Division P.O. Box 85357		
·			X Commercial
Telephone	(619) 277-8900, Ext. 3778/2130		Technology
STATUS			
	Operational OPtenned	pou	□ Operations
Approved		Scandidate Opportunity	Tune Number 7
First flia	r 1991		(see Table A)
No. of flights	''		Importance of the
Duration o	ght, days		Space Station to
OBJECTIVE	•		this Element
To develop	To develop the technology and demonstrate performance for inter-	erformance for inter-	1 - low online but
satellite d laser optica	satellite data transfer, at near megabit data rates, employing laser optics and CO ₂ NdYAG or TBD gases.	ita rates, empioying	Could usa
	ı		
			Scale 1 - 16 7
DESCRIPTION			
A laser transmitter		delivered to the SS of	and receiving system is delivered to the SS and installed with an inertial
flight or launch of	aunch of a subsatellite, a secon	nd laser transmitter ar	subsatellite, a second laser transmitter and/or receiver is in space.
The Shuttle or subset form track, acquisit	٠. ص	a sufficient distance mission and reception C Time to reacouire comm	atellite must back away a sufficient distance (hundreds of miles) to per- tion, lock-up and transmission and reception of data between the two laser rates will be measured. Time to reacquire communications, if interrupted.
will be determined	•	year 1991 and 1992.	

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1 0 8 Page 2 of 3	† 1		Continuous	(MHZ) TBD:	(2
CODE G D C D 1 1 0 8	Apogee, km. Any Periges, km. Any Tolerance + Inclination, deg Any Tolerance + Nodel Angle, deg Escane dV Required.m/s	ENTA ON (1f urac urac	rating indby ik	DATA/COMMUNICATIONS Monitoring requirements: Noncomment	Data Types: Analog Digital Hrs/Day No Eilm (Amount) 5 minutes Voice (Hrs/Day) No Live TU (Hrs/Day) Live TU (Hrs/Day) On-Board Storage (MBIT) Up to 1000 Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 100,000 Downlink Frequency (MHZ)

CODE 6.0 c 0 1 1 0 8 Page 3 of 3	o, deg C operational min non-operational min tion, w operational min non-operational min non-operational min	PHYSICAL CHARACTERISTICS Internal External Remot ID/Function Pressurized Unpre L,m 2 U,m L,m 2 U,m Launch mass, kg Consumables Types	1 SKILL LEVEL Hrs/D	ce consumables, kg kg Man Hours SiInterval, day Man/Hrs Req. Deliverables, kg Returnables, kg	This retu
THERMAL		EQUIPMENT PHYS Location: [] Equipment ID/F	CREU REQUIREMENTS Crew Size Skills (See Table	SERVICE INCOMPINTENAN SERVICE INCOLORIA Returnables CONFIGURATION CHANGE SPECIAL CONSIDERATIC	Signal acquisition must be achieved. SS laser should be

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GOCD CODE 1108	ELEMENT NAME	LASER COMMUNIC	ATIONS
ACCOMODATION:	ACHED	FLYER OTV O	rs
1. STATION ACTIVATION (E.G.	., SET-UP/ASSEMBLY	ATTACHMENT AND CH	ECKOUT)
DATE(S) 1991 INT	. HRS 2.5	EVA HRS 2.5	EVA CREW 1
1992	2.5	2,5	_1
☐ NOT APPLICABLE			
2. SERVICE (E.G., REPLENISH/	RESUPPLY)		
INTERVAL DAYS	TOTAL SERVICES	·	
TMS/OTV REQUIRED		STATION HRS P	ER SERVICE
■ NOT APPLICABLE		EVA HRS PER S	ERVICE
		EVA CREW SIZE	
3. STATION OPERATIONAL SU	PPORT (AVG. TIME F	OR MONITOR, INSPECT	, ETC.)
0.5 HRS PER DAY (II	NTERNAL)		
HRS PER DAY (E	(AV		
☐ NOT APPLICABLE	•		
4. RECONFIGURATION			
INTERVAL DAYS	TOTAL RECONF	IGS	
TMS/OTV REQUIRED		STATION HRS PE	R RECONFIG
☑ NOT APPLICABLE		EVA HRS PER RE	ECONFIG
		EVA CREW SIZE	
5. DEACTIVATION/REMOVAL			
DATE(S) 1991 INT.	HRS. 2.5	EVA HRS _2.5	EVA CREW 1
1992	2.5	2.5	_1
☐ NOT APPLICABLE			
6. NOTES (BRIEFLY DESCRIBE	TASKS IN 1 THROU	GH 5 ABOVE)	
 Set up laser Two flights, 5 of Remove equipment 	lays each, 0.5	hr./day	

Code: GDCD 1108

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Laser Communications

Reference Documents:

Supplied by SPACECOM under subcontract to GDC

Narrative:

Space Station offers a unique opportunity to develop the technology for space-to-space, very high data rate communications employing lasers. Competing laser technologies, such as CO₂ and NdYAG can be tested and results compared for signal/noise, bit error rate, sensitivity to jitter and capability to lock-on to a receiver or transmitter.

The approach to the conduct of a laser intersatellite test requires that an optical receiving system be located some distance from the Space Station-based laser transmitter. This can be accomplished by the deployment of a suitable equipped subsatellite from the Space Shuttle, use of a shuttle-based pallet or cooperation with some other laser receiver equipped satellite, U.S. or international. The Space Station will house an instrument pointing system for the laser transmitter which should have an accuracy of better than 0.5 degree.

The astronaut-scientist on the station will be responsible for attaching the laser package to the pointing system and power supply, seeing that the equipment is operating, assist in calibrating the instrument, point it in the correct direction and observe that lock-up has occurred and that data is flowing.

CODE Science & Applications			Page 1 of 3
CONTACT N. HardyJ. Peterson MZ 21-9530 Addreas P.O. Box 85357 San Diego, CA 92138 Telephone (619) 277-8900, Ext. 3778/2130 STATUS Character of Flight, Mr. 1993 Duration of Flight, days To determine the feasibility of operating high-power, RF, amplitier to before and after opening the vacuum envelopes and then resealing and resealing and returning the tubes space is to use a meltable gasket of indium. Tube operating heat would be sufficient to the indium before separation of After return to Earth's Seal in the vacuum envelopes and then resealing and resealing and resealing the vacuum envelope space is to use a meltable gasket of indium. Tube operating heat would be sufficient to the indium before separation of After return to Earth the internal content of some tube would be san jazed with tubes that were no ed to space. The in-orbit procedure would be to place one tube at a time on an extendable operate the tube and then return the tube to the Space Station interior.		CODE	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Addrass General Dynamics Convair Division Addrass Addrass Addrass An Diego, CA 92138 San Diego, CA 92138 San Diego, CA 92138 Telephone Gisp 277-8900, Ext. 3778/2130 Candidata Type Number Type Number Type Number Candidata Type Number Type Numbe	Upen Envelope lube		Science &
Telephone (619) 277-8900, Ext. 378/2130 Telephone (619) 277-8900, Ext. 378/2130 STATUS Chorational Ecandidata Operational Ecandidata Chorational Ecandidata Deportunity First flight, yr 1993 No. of flights, days First flight, days Type Number Space Stalion to Objective To determine the feasibility of operating high-power, RF, amplification of Flight, days First flights To determine the feasibility of operating high-power, RF, amplification to the space environment in the vicinity of a spacecraft located outside of the Earth's atmosphere. DESCRIPTION The experiment would consist of measuring the performance of several tube before and after opening the vacuum envelopes and then resealing and resealing the vacuum envelope space is to use a meltable gasket of indium. Tube operating heart would be sufficient to the indium before separation of the collector cover. Removal of tube power would reseal tube after the cover is replaced. After return to Earth the internal content of some tube would be analyzed while others would be life tested and compared with tubes that were no ed to space. The in-orbit procedure would be to place one tube at a time on an extendable operate the tube and then return the tube to the Space Station interior.	W. Hardy General		Applications (non-commercial)
Telephone (619) 277-8900, Ext. 3778/2130 STATUS Operational Ecandidate Operational Ecandidate Importance of the First filght, yr 1993 No. of filghts 2			X Commercia(
Operational Planned Operations	72 (619)		Technology
Operational Scandidate Type Number T	STATUS		
First flight, yr 1993 No. of flights 2 Duration of Flight, days 7 OBJECTIVE To determine the feasibility of operating high-power, RF, ampli-1 Fier tubes which are open to the space environment in the fier tubes which are open to the space environment in the vicinity of a spacecraft located outside of the Earth's atmosphere. DESCRIPTION The experiment would consist of measuring the performance of several tube space is to use a meltable gasket of indium. Tube operating heat would be sufficient to the indium before separation of the collector cover. Removal of tube power would the some tube would be analyzed while others would be 1ife tested and compared with tubes that were no ed to space. The in-orbit procedure would be to place one tube at a time on an extendable operate the tube and then return the tube to the Space Station interior.		Jed Ldate	Operations
First flights 1993 No. of flights 2 Duration of Flights 2 Duration of Flights 2 OBJECTIVE To determine the feasibility of operating high-power, RF, ampli- fier tubes which are open to the space environment in the vicinity of a spacecraft located outside of the Earth's atmosphere. DESCRIPTION The experiment would consist of measuring the performance of several tube before and after opening the vacuum envelopes and then resealing and returning the tubes earth laboratory. One technique suitable for unsealing and resealing the vacuum envelop space is to use a meltable gasket of indium. Tube operating heat would be sufficient to the indium before separation of the collector cover. Removal of tube power would reseal tube after the cover is replaced. After return to Earth the internal content of some tube would be analyzed while others would be life tested and compared with tubes that were no ed to space. The in-orbit procedure would be to place one tube at a time on an extendable operate the tube and then return the tube to the Space Station interior.		rtunity	Type Number
To determine the feasibility of operating high-power, RF, amplifier tubes which are open to the space environment in the voltal use vicinity of a spacecraft located outside of the Earth's atmosphere. DESCRIPTION The experiment would consist of measuring the performance of several tube before and after opening the vacuum envelopes and then resealing and returning the tubes space is to use a meltable gasket of indium. Tube operating heat would be sufficient to the indium before separation of the collector cover. Removal of tube power would reseal tube after the cover is replaced. After return to Earth the internal content of some tube would be analyzed while others would be life tested and compared with tubes that were no ed to space. The in-orbit procedure would be to place one tube at a time on an extendable operate the tube and then return the tube to the Space Station interior.	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		(see Table A) Importance of the Space Station to
To determine the feasibility of operating high-power, RF, ampliary of a spacecraft located outside of the Earth's atmosphere. DESCRIPTION The experiment would consist of measuring the performance of several tube before and after opening the vacuum envelopes and then resealing and returning the tubes space is to use a meltable gasket of indium. Tube operating heat would be sufficient to the indium before separation of the collector cover. Removal of tube power would reseal tube after the cover is replaced. After return to Earth the internal content of some tube would be analyzed while others would be life tested and compared with tubes that were no ed to space. The in-orbit procedure would be to place one tube at a time on an extendable operate the tube and then return the tube to the Space Station interior.			this Eloment
DESCRIPTION The experiment would consist of measuring the performance of several tube before and after opening the vacuum envelopes and then resealing and returning the tubes earth laboratory. One technique suitable for unsealing and resealing the vacuum envelopes space is to use a meltable gasket of indium. Tube operating heat would be sufficient to the indium before separation of the collector cover. Removal of tube power would reseal tube after the cover is replaced. After return to Earth the internal content of some tube would be analyzed while others would be life tested and compared with tubes that were no ed to space. The in-orbit procedure would be to place one tube at a time on an extendable operate the tube and then return the tube to the Space Station interior.	To determine the feasibility of operating hi fier tubes which are open to the space envir vicinity of a spacecraft located outside of	f, ampli- ne	
DESCRIPTION The experiment would consist of measuring the performance of several tubbes before and after opening the vacuum envelopes and then resealing and returning the tubes earth laboratory. One technique suitable for unsealing and resealing the vacuum envelopes pace is to use a meltable gasket of indium. Tube operating heat would be sufficient to the indium before separation of the collector cover. Removal of tube power would reseal tube after the cover is replaced. After return to Earth the internal content of some tube would be analyzed while others would be life tested and compared with tubes that were no ed to space. The in-orbit procedure would be to place one tube at a time on an extendable operate the tube and then return the tube to the Space Station interior.	a uno sprier e .		Scale 1 - 10 5
earth laboratory. One technique suitable for unsealing and resealing the vacuum envelop space is to use a meltable gasket of indium. Tube operating heat would be sufficient to the indium before separation of the collector cover. Removal of tube power would reseal tube after the cover is replaced. After return to Earth the internal content of some tube would be analyzed while others would be life tested and compared with tubes that were no ed to space. The in-orbit procedure would be to place one tube at a time on an extendable operate the tube and then return the tube to the Space Station interior.	DESCRIPTION The experiment would consist before and after opening the vacuum envelope	L of measuring the per es and then resealing	formance of several tubes and returning the tubes to an
the indium before separation of the collector cover. Removal of tube power would reseal tube after the cover is replaced. After return to Earth the internal content of some tube would be analyzed while others would be life tested and compared with tubes that were no ed to space. The in-orbit procedure would be to place one tube at a time on an extendable operate the tube and then return the tube to the Space Station interior.	earth laboratory. One technique suitable for space is to use a meltable gasket of indium.	or unsealing and resea . Tube operating heat	ling the vacuum envelope in would be sufficient to melt
would be analyzed while others would be life tested and compared with tubes that were no ed to space. The in-orbit procedure would be to place one tube at a time on an extendable operate the tube and then return the tube to the Space Station interior.	the indium before separation of the collecto tube after the cover is replaced. After retu	or cover. Removal of t urn to Earth the inter	ube power would reseal the nal content of some tubes
operate the tube and then return the tube to the Space Station interior.	would be analyzed while others would be life ed to space. The in-orbit procedure would be	e tested and compared e to place one tube at	with tubes that were not open- a time on an extendable bcom
Two experiments per year/1993 and 1994.	operate the tube and then return the tube to Two experiments per year/1993 and 1994.	o the Space Station in	terior.

G D C D 1 1 0 9 Page 2 of 3	Tolerance +Ephemeris Accuracy, m	Field of view, deg	Duration, hrs/day Continuous Continuous Cy, Hz	Other Frequency (MHZ)	Voice (Hrs/Day) Oolce (Hrs/Day) Other TDRSS Compatible Downlink Frequency (MHZ) Ku/Ka-Band
	ORBIT CHARACTERISTICS Apogee, km Any Perigee, km Any Inclination, deg Any T Nodal Angle, deg	1G/ORIENTATION Inertial Solar So	AC	DATA/COMMUNICATIONS Monitoring requirements! Mone	Data Types! Analog XDigital Film (Amount) Photos None Live TU (Krs/Day) None On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 100 D

CODE 6 D C D 1 1 0 9		_
THERMAL Active X Passive Temperature, deg C operational min	0	_
non-operational min operational min		
S I Remote		
Launch mass, kg 157 Deployed Consumables Tupes		
CREU REQUIREMENTS		
		
1 I		
	T	
FUA X VEC TANA Install/Penning		
Konson		
Interval		
Deliverables, kg	T	
A number of open envelope tubes will be brought to the SS to be deployed on an extendible boom away from the SS body (to avoid contamination).	LLO O	
	-	

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1109	ELEMENT NAME	OPEN ENVE	LOPE TUBE	
ACCOMODATION: 🐼 ATTA				
1. STATION ACTIVATION (E.G.,	SET-UP/ASSEMBLY	ATTACHMENT	AND CHECKOUT)	
DATE(S) 1993 INT.	HRS	EVA HRS2	EVA CRE	:w_1
1994	2	2		_1
NOT APPLICABLE				
2. SERVICE (E.G., REPLENISH/R	ESUPPLY)			
INTERVAL DAYS	TOTAL SERVICES	.		
TMS/OTV REQUIRED _		STATIO	N HRS PER SERVI	CE
▼ NOT APPLICABLE _		EVA HR	S PER SERVICE	
		EVA CR	EW SIZE	
0.25 HRS PER DAY (IN HRS PER DAY (EV NOT APPLICABLE 4. RECONFIGURATION INTERVAL DAYS TMS/OTV REQUIRED	TOTAL RECONF	STATION	 I HRS PER RECON	
☑ NOT APPLICABLE			S PER RECONFIG. EW SIZE	
5. DEACTIVATION/REMCVAL DATE(S) 1993 INT. F		EVA HRS		
☐ NOT APPLICABLE				
6. NOTES (BRIEFLY DESCRIBE	TASKS IN 1 THROU	GH 5 ABOVE)		
 Set up plus stati 2 experiments, 7 Station OPS 		th .25 hou	rs/day req.	

Code: GDCD 1109 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Open Envelope Tube

Reference Documents:

Supplied by SPACECOM under subcontract to GDC

Narrative:

A major technical problem to the development of long life, high performance space communications electronic tubes is the deterioraztion of the vacuum inside the tube envelope caused by outgassing, overheating, barium deposition, or insulators and onput window cracking due to thermal stresses. One concept to maintain vacuum is to utilize the infinite pumping capacity of space by opening the tube to the space vacuum. Such a tube could be redesigned for simpler fabrication by eliminating the ion pump employed to maintain vacuum and the removal of output waveguide windows.

Space Station affords the communications engineer the opportunity to test a number of competing techniques for tube envelope removal in space. The tube should be placed on an extendible boom and deployed at a distance from the station to avoid any contamination. An electrical command from the astronaut will "blow" the cover. Tube operating characteristics and temperature distribution in the collector will be measured and transmitted to earth.

L	•
Spaceborne Interferometer	
rson MZ 21-9530 Convair Division	Applications (non-commercial)
San Diego, CA 92138	⊠Commercia l
Telephone (619) 277-8900, Ext. 3778/2130	Technology
STATUS Operational Operational XCandidate	Operations
	Tupe Number
First flight, yr 1995 No. of flights 2 Duration of Flight, days 15	
OBJECTIVE	
To develop the spaceborne technology of providing position locations of mobile platforms (ships, aircraft, etc.) using a single satellite.	1 - low value but could use 10 - vital
	Scale 1 - 10 5
DESCRIPTION Angle measurement via the interferometer technique requires mutually perpendicular, long baseline antennas. Employing the L-band frequency would require antenna separation of about 40 meters. Each interferometer consists of antennas on booms extending out from the SS, plus electronics for amplifying, frequency shifting, and combining the received signals for retransmission to the ground where phase measurements are performed. Antenna separation distance must be accurately known. A total of 4 RF subelements are required. Fixed platforms, whose location is known to within ±5km, will transmit signals to the SS, when it comes within view. Knowledge of the SS location, phase measurements from the interferometer and distance from SS to platform provide data to give the location of the fixed or moving platform. Second flight in 1997. Payload could be classified as Technology Development.	que requires mutually perpendi- would require antenna separation on booms extending out from the combining the received signals performed. Antenna separation s are required. Fixed platforms, to the SS, when it comes within he interferometer and distance fixed or moving platform. Second velopment.

CODE 6 0 C 0 1 1 1 0 Page 2 of 3	RESTICS NY Periges, km Any Tolerance + leg Any Tolerance + leg Any Ephemeris Accuracy, m ±100	TAT IC KI IL LE		ents! bltime []Of uption Requir mand Rate (Ki rocessing Rec	100
		בר א שר הר הר א הר הר א הר הר א הר הר הר הר הר הר הר הר הר הר הר הר הר	OUER Ac XD Operating Standby Peak	MMUNICATION Ing require XR Yption/Dec Ink Req. 1 Cc Board Data cription osed data rat	ata Types! Ilm (Amount) Ive TU (Hrs/D n-Board Store

Temperature, deg C operational ain max non-operational ain max collibrations of the collibration of the collib
CAL CHARACTERISTICS Thermal External Remote Lim 30 Uim 0.6 Him 0.6 Lim 30 Uim 0.2 Him 0.6 Consumables types Acceleration sensitivity, g min max Acceleration sensitivity, g min max Acceleration sensitivity, g min max 15 Task Assignment TA Task Assignment TA Task Assignment Consumables, kg Hrs/Day 0.5 Hrs/Day 0.5 Consumables, kg Ann Hours Han/Hrs Req. Beliverables, kg Ann Hours Adelections is important to determining the technical practicality of this boom movement causes phase changes to the interferometer, which changes the accuracy.
Consumables types Acceleration sensitivity, g min max Acceleration sensitivity, g min max IS I Task Assignment LEVEL 5 Hrs/Day 0.5 Hrs/Eucl 3 Hrs/Eucl 3 Hrs/Eucl 16 INO Reason Set-Up/Remove Hrs/Eun 16 INO Reason Set-Up/Remove Hrs/Eun 16 INO Reason Set-Up/Remove Hrs/Eun 16 INO Reason Set-Up/Remove Hrs/Eun 16 INO Reason Set-Up/Remove Hrs/Eun 16 IND Reason Set-Up/Remove 16 IND Reason Se
Task Assignment BY SKILL CEVEL Ars/Day O.5 Hrs/Day O.5 Hrs/EUA Hrs/
SKILL S Hrs/EUEL 3 Hrs/EUA 16
Hrs/Day 0.5 NANCE INANCE INANCE INANCE INANCE INANCE INANCE INANCESIInterval, day Deliverables, kg Man/Hrs Req. Man/Hrs Req. ATIONS/See Instructions deflections is important to determining the technical practicality of this soom movement causes phase changes to the interferometer, which changes the incuracy.
INANCE . days . days . los, kg . Man Hours . Man/Hrs Roq. Dollverables, kg . Returnables, kg . ATIONS/See Instructions deflections is important to determining the technical practicality of this noom movement causes phase changes to the interferometer, which changes the ccuracy.
Consumables, kg NGES:Interval, day ANGES:Interval, day ANGES:Interval, day ANGES:Interval, day ATIONS/See Instructions AFIONS/See Instructions AFIONS/See Instructions ACTIONS/See Instructions
ANGES:Interval, day Deliverables, kg ATIONS/500 Instructions deflections is important to determining the technical practicality of this couracy.
ATIONS/Soc Instructions deflections is important to determining the technical practicality of this couracy.
deflections is important to determining the technical practicality of this oom movement causes phase changes to the interferometer, which changes the ccuracy.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GOCD CODE 1110 ELEMENT NAME	SPACE BORNE INTERFEROMETER
ACCOMODATION: 🛭 ATTACHED 🗆 FRE	
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY	/ATTACHMENT AND CHECKOUT)
DATE(S) 1995 INT. HRS 8	EVA HRS 8 EVA CREW 1
1997 8	8 1
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICE	5
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME	FOR MONITOR, INSPECT, ETC.)
0.5 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	•
■ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL OAYS TOTAL RECON	FIGS :
	STATION HRS PER RECONFIG.
NOT APPLICABLE	EVA HRS PER RECONFIG.
a not an algebra	EVA CREW SIZE
-	
5. DEACTIVATION/REMOVAL	_
DATE(S) 1995 INT. HRS. 8	EVA HRS 8 EVA CREW 1
	_81
□ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROU	GH 5 ABOVE)
1. Set up plus station OPS	
3. Based on flights in 1995 an .25 hours/day required.	d 1997 of 15 days each with
5. Station OPS	

Code: GDCD 1110

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Spaceborne Interferometer

Reference Documents:

Supplied by SPACECOM under subcontract to GDC

Narrative:

The spaceborne interferometer is a space station system using widely spaced antennas to track various moving platforms such as airplanes, ships, balloons, bouys, etc.

This feature could provide an air traffic control or ship coordination application.

The technology for space-based interferometers needs to be developed and demonstrated. Potential technical problems of boom deflection and spacecraft jitter and stabilization on the location accuracy must be tested. Space Station affords the opportunity to develop the techniques and demonstrate the position determination accuracy of interferometers.

Booms of varying length and antennas with different RF feeds could be housed on Space Station to demonstrate different applications. Aircraft and ship positioning should use the 1.5 GHz band, while search and rescue and data collection would use the 401-406 MHz band. The astronauts would install the antenna and feed booms at the ends of Space Station elements to form a long, crossed-baseline interferometer. They would periodically inspect the antenna and electronics for proper operations.

		Page 1 of 3
PAYLOAD ELEMENT NAME CODE Millimeter Wave Propagation 6 0 c n 1 1 1	-	
NONTACT W. Hardy/J. Peterson MZ 21-9530	Application	tions
053		
San Diego, CA 92138	X Commercial	
Telephone (619) 277-8900, Ext. 3778/2130	Technology	
STATUS		
חפו	0 Operations	•
Approved Approved		7
1991	(See Table A)	
No. of flashing 3		1 1 1
Duration of Flight, days 5	Space Station	100
OBJECTIVE	this Element	
To provide propagation data needed for future communications satellite services at frequencies assigned by recent interna-	tions 1 . low value but	a but
tional meetings (WARC-79), above 30 GHz.	10	3
	Scale 1 - 10	. 9
DESCRIPTION A dish-type antenna plus a single channel transmitter will be placed on the	transmitter will be place	ced on the
foreign countries. Various EIRP levels will be transmitted from the SS for reception at the	tted from the SS for rece	eption at the
ية ية ق	-noise measurements will og, snow). Two experimer in 1993.	be taken, as a nts in the
Five days each for 2 experiments; 2920 days for continuous monitoring (3rd launch).	ous monitoring (3rd laund	ch).

CODE 6.0.0.1.1.1.1 Page 2 of 3
Periges, km Any Tolerance + Any Tolerance + Ephemeris Accuracy, m
POINTING/ORIENTATION Use direction Incrtiate Solar Earth Truth Sites (if known) Pointing accuracy, arc sec 3600 Field of view, deg Near Hemispherical Pointing Stability (Jitter)arc sec/sec
POWER Operating 25 Standby 100 Voltage, V 28 Frequency, Hz
AMUNICATIONS Ing requirements: Realtime XOf ryption/Decryption Requir Ink Req.:Command Rate (KI Board Data Processing Req
Data Types! Analog Digital Hra/Day Film (Amount) Photos Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) Downlink Frequency (MHZ) Above 30 GHZ

ORIGINAL PAGE IS

(C)		or Poor Qu	ALIT	Υ							
1 1 1 1 Page 3 of		Stowed Deployed				4	. 0	Roa. 4	blos, kg		Reconfiguration involves adjusting/changing frequency producing module in pressurized volume.
CODE 6.0.0.1.1.1.1	X X X X 4 4 5 6 6 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	3 3 40				Hrs/EUA					module ir
0		ERISTICS External Remote PressurizedX Unpressurized 3 U,m 0.5 H,m nass, kg bles Types	ent t			/Rem	mables.	Man Hours			producing
	11. 11.	CS Inized Remoturized Unpre U, m 0.5 U, m 0.5 Kg ypes	Assignment	2	0.25	1/Service		.	5	ons	requency
		STICS arnal Lasuriza Lam Lam Lam Lam Lam Lam Lam Lam Lam La	Task		/Day	Roason Install/Service/Rem		1 days	ables,	TIONS/See Instructions	changing 1
	X Passive operational non-operational operational	CHARACTERISTICS nal Starnal on Pressuri L,m 3 U, L,m 3 U, Caunch mass, kg Consumables Type		SKILL	Hrs/Day	Roas		5	Deliver	1/500 In	djusting/o
•	် ၁ အ	PHYSICAL CHARAC X Internal ID/Function L,m L,m Consum Accele	4TS 1	Table B)		S	TENANCE	ables, I		ERATIONS	nvolves a
	THERMAL Mactive Temperature, de Heat Rejection,		REQUIREMENTS Sizo	0		X YES	SERVICING/MAINTENANCE SERVICE: Interval, days	Return		SPECIAL CONSIDERAT	guration i
	THERMAL	EQUIPMENT Location: Equipment	CREU REOU	3		EUA 🗵	SERVICE	CONFICH		SPECIAL	Reconfi

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GOCO CODE 1111 ELEMENT NAME MI	LLIMETER WAVE PROPAGATION
ACCOMODATION: 🛭 ATTACHED 🔲 FREE FL	YER OTV OPS
I. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/AT	FACHMENT AND CHECKOUT)
DATE(S) 1991 INT. HRS 2.0 EV	A HRS 2.0 EVA CREW 1
1992 2.0	2:8 -1
NOT APPLICABLE	2.0
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
M NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR	MONITOR, INSPECT, ETC.)
0.25HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	•
□ NOT APPLICABLE .	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONFIGS.	. 1
	STATION HRS PER RECONFIG. 2
	EVA HRS PER RECONFIG. 2
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	2.0
DATE(S) 1991 INT. HRS. 2.0 EVA	
1992 2.0 ☐ NOT APPLICABLE	2.01
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH S	5 ABOVE)
1. Set up plus station OPS	
3. 2 flights, 1991 and 1992, 5 days in 1993 with continuous monitor	s each with .25 hrs/day. Relaunch ing and adjustments from 1993-2000,
0.25 hr/day.	•
 Reconfig. for 1993 (launch only) Station OPS for 1991 and 1992 la 	aunches. Launch in 1993 continues
after year 2000 and does not red	wire deactivation

Code: GDCD 1111

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Millimeter Wave Propagation

Reference Documents:

Supplied by SPACECOM under subcontract to GDC

Narrative:

The 1979 World Administrative Radio Conference (WARC) assigned new frequency bands for future comsat applications and research needs in the millimeter waveband (30-300 GHz). Prior to use of these bands for space applications and communications, the basic characteristics of the frequency band is required, such as: effects on the signal due to fog, rain, snow, elevation angle, and terrain. The performance data of the various new RF components, antenna, and antenna feeds are also to be obtained. Some of the bands of interest to comsat developers and users are: Broadcast - 41.5 and 48.5 GHz; Mobile-40 and 51 GHz; and Fixed Service - 43/39 GHz. Space Station affords the opportunity to place various laboratory developed receivers, transmitters, antennas, feeds, and associated components in space to conduct propagation and performance (S/N, EIRP, G/T) tests.

The Space Station will provide the platform to house the different antennas and associated RF equipments and conduct the propagation tests. The astronauts will be required to connect power lines to the equipments, assure that the antenna is properly stabilized and observe instruments that indicate that a proper RF signal is being transmitted. Installation of a new feed system may also be required.

Section 2.3

Discipline Materials Processing

GDCD ID NO.	PAYLOAD ELEMENT NAME
1200	Pilot - Biological Processing Facility
1201	Pilot - Containerless Processing Facility
1202	Pilot - Furnace Processing Facility
1203	Commercial - Biological Processing Facility
1204	Commercial - Containerless Processing Facility
1205	Commercial - Furnace Processing Facility
1206	Electrophoresis Free-Flyer
1207	Electrophoretic Separation
1208	Crystal Growth
1209	Metal Clusters and Crystal Growth
1210	Enzyme Production and Separation
1211	Silicon Crystals
1212	Heat Resistant Alloys
1213	Chemical Reactions
1214	Space Isothermal Furnace System (SIFS)

		Page 1 of
PAYLOAD ELEMENT NAME Pilot - Bio Proc Facility 6 0	c 0 1 2 0 0	•
		Applications (non-commercial)
San Diego, CA 92138		X Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Technology Development
STATUS		Operations
	75.	Type Number 8
First flight, yr 1992 No. of flights 1 Duration of Flight, days 730		Importance of the Space Station to
Provide a moderate scale biological processing facility for process development and optimization, and initial commercial output.	-	1 = low value but could use
		Scala 1 - 10 10
DESCRIPTION This facility contains processing and support equipment for development of processes such as continuous flow and stationary column electrophoresis and isoelectric focusing, for the purification and separation of biologicals such as cells, proteins and hormones.	pment for devel sis and isoelec ls, proteins an	lopment of processes such as ctric focusing, for the puri- nd hormones.
	•	

ARACTERISTICS km >400 lon, deg gle, deg gle, deg May ORIENTATION accuracy, arc sec Stability (Jitter) arc sec/sec Stability (Jitter) arc sec/sec Restrictions (Avoidance) C Restrictions (Avoidance) Frequent NUNICATIONS AND To (Arc i Command Rate (KBS) Oard Data Processing Required ription Types!	CODE 6.0 C.0 1.2.0 0 Pege 2 of 3	>400 Periges, km >400 Tolerance + deg Any Tolerance + Ephemeris Accuracy, m	DINTING/ORIENTATION Low direction Incrtial ruth Sites (if known) ointing accuracy, arc sec ointing Stability (Jitter) arc	C XDC Power, Brating 8000 150 and by 150 10,000 U	ents: XOf Nitime XOf yption Requir mand Rate (Ki rocessing Rec	Types: Analog (Amount) TU (Hrs/Day) ard Storage (MBIT) Dump Frequency (Per Or
--	----------------------------------	---	---	---	--	---

	C
nin max	າ
Heat Rejection, w operational min 8000 max 10,000 non-operational min 150 max	
S Remote Ized Unbressurized	
ت ال 2 - ال 3 - ال	
ables Types Cells, Proteins, Filtertion sensitivities a min 10-3	
Tack dealers	
oo Tablo B) SKILL	
Hrs/Day 2 2	
Consumables	
GESIInterval, day Man Hours Man/Hrs Roq.	
tructions	
Vacuum vents are required.	

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix 1

GDCD CODE 1200 ELEMENT NAME	PILOT PRODUCTION - BIOLOGICAL PROCESSING FACILITY
ACCOMODATION: ATTACHED FRE	E FLYER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY	'/ATTACHMENT AND CHECKOUT)
DATE(S) 1992 INT. HRS	EVA HRSEVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	S
TMS/OTV REQUIRED	STATION HRS PER SERVICE
NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME	FOR MONITOR, INSPECT, ETC.)
4 HRS PER DAY (INTERNAL) 26 day	s per month.
HRS PER DAY (EVA)	
□ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONF	ei Ge
☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) 1994 INT. HRS.	EVA HRS EVA CREW
□ NOT APPLICABLE	
U NUT APPEICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROU	GH 5 ABOVE)
 and 5. Station operations. Crew activity description: M load/unload samples, preserve Repair equipment as necessar Some equipment operates 24 ho 	

TOTAL EVA HRS 0

Code: GDCD 1200

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Pilot Production - Biological Processing Facility

Reference Documents:

1. TRW Report MPS .6-80-286, Vol. II, "MEC Payloads Handbook", 30 January 1981

Narrative:

This is a pilot production facility for biological processing process development and optimization, and for initial commercial output.

The facility contains processing and support modules as shown below:

Proce	essing Module	Support Module	Pwr, kw
CFE SEC IEF	(10 Columns) (5 Columns) (10 Columns)	1	2-8/10

Multiple columns can be run in parallel, but all columns cannot be run simultaneously.

Equipment physical characteristics were derived from Ref 1, Section 11. They are summarized in Table 1200-1.

Launch date and mission duration were derived.

- 1. Descriptive data for all attached payload elements is based upon MPS .6-80-286, Vol. II, MEC Payloads Handbook (TRW). All mass and volume values include a 25% growth factor.
- 2. Power levels shown are for the largest specimen sizes.

Code: GDCD 1200

PAYLOAD ELEMENT SYNTHESIS

3. Abbreviations used are as follows:

AC Acoustic Containerless **ASES** Advanced Solidification Experiment System BIO Biological CFE Continuous Flow Electrophoresis Electromagnetic Containerless **EMC ESC** Electrostatic Containerless Floating Zone FZ F/C Fluids/Chemistry High Gradient Directional Solidification HGDS IEF Isoelectric Focusing Solution Crystal Growth SCG SEC Stationary Electrophoresis Column VCG Vapor Crystal Growth

4. The source data expresses equipment sinze in terms of volume rather than dimensions. In a manned laboratory the equipment would be packaged in equipment racks, or with dimensions similar to racks. Therefore, to derive the L by W by H dimensions required for the Payload Element Data Sheets, rack cross-sections of 2m high by 0.75m deep were assumed. The

rack length was then calculated by: $L = \frac{V}{1.5}$ m

Page 3 of 3 Volume II, Book 1 Appendix I

Code: GDCD 1200

PAYLOAD ELEMENT SYNTHESIS

TABLE 1200-1 EQUIPMENT PHYSICAL CHARACTERISTICS

PROC	CFS S		ESSING Dule	SUP I		TOT	ALS
(QT		MASS kg	VOLUME m3	MASS kg	VOLUME m3	MASS kg	VOLUME m3
BIO: CFE SEC IEF	(25) (10) (10) (10)	670	2.1	380	2.2	1,050	4.3

	Page 1 of 3
PayLOAD ELEMENT NAME Pilot - Containerless Proc Facil	TYPE Science A
W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division	Applications (non-commercial)
Hadrass P.O. Box 85357 San Diego, CA 92138	X Commercia!
Telephone (619) 277-8900, Ext. 3778/2130	- Tachnology Development
) a l	Operations
☐ Approved	
First flight, yr 1994 No. of flights 1 Duration of Flight, days 1095	Importance of the Space Station to
	this Elomont
Provide a moderate scale containerless processing facility for process development and optimization, and initial commer- cial output.	1 = low value but could use 10 = vital
	Scale 1 - 10 10
DESCRIPTION	
This facility contains processing and support equipment for the development of processing · such as acoustic, electromagnetic and electrostatic containerless processing for the production of ultrapure glasses, alloys, ceramics and crystals.	development of processing . ss processing for the produc-

ORIGINAL PAGE IS OF POOR QUALITY

\$5. 1 1 1 m

	_
T CHARACTERISTICS DO, km >400 Periges, km >400 Ination, deg Any I Angle, deg Ephemeris Accuracy, m Do do Required.m/s	
TION Inertial Solar Earth Inertial Solar Earth Jacc sec Field of view, deg (Jitter)arc sec.sec (Avoidance)	OF F
Ing 12,000 byration, hrs/day 12,000 4 4 Continuous Frequency, Hz	POOR QUALITY
DATA/COMMUNICATIONS Monitoring requirements: None (X)Realtime Offline Other None (X)Realtime Offline Other Encryption/Decryption Required Uplink Req.: Command Rate (KBS) X)On-Board Data Processing Required Description	
Data Types: Analog XDigital XHrs/Day 8 Film (Amount) 2 Live TU (Hrs/Day) 2 On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 3 Downlink Frequency (MHZ)	

ORIGINAL PAGE 19 OF POOR QUALITY

m	
THERMAL Thermal Thermal Tomperature, deg C operational min max non-operational min min max non-operational min min max non-operational min non-operatio	

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 1201 ELEM	NT NAME PILOT PRODUCTION - CONTAINERLESS PROCESSING
ACCOMODATION: X ATTACHED	☐ FREE FLYER ☐ OTV OPS
1. STATION ACTIVATION (E.G., SET-UP	ASSEMBLY/ATTACHMENT AND CHECKOUT!
DATE(S) 1994 INT. HRS	EVA HRS EVA CREW
NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPP	Υ)
INTERVAL DAYS TOTA	L SERVICES
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT	AVG. TIME FOR MONITOR, INSPECT, ETC.)
8 HRS PER DAY (INTERNA	L) 26 days per month (crew and equipment)
,HRS PER DAY (EVA)	
☐ NOT APPLICABLE	•
4. RECONFIGURATION	·
INTERVAL DAYS TO	AL RECONFIGS.
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
,	EVA HRS EVA CREW
☐ NOT APPLICABLE	

- 6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)
- 1. and 5. Station operations.
- 3. Crew activity description: Monitoring, Control/mainpulate, measure/record, load/unload samples, clean out equipment, package samples.

TOTAL EVA HRS_	0
----------------	---

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 1201

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Pilot Production - Containerless Processing Facility

Reference Documents:

1. TRW Report MPS .6-80-286, Vol. II, "MEC Payloads Handbook", 30 January 1981

Narrative:

This is a pilot production facility for containerless processing process development and optimization, and the initial commercial output.

The facility contains processing and support modules as shown below:

Processing Module	Support Module	<u>Pwr, kw</u>
AC (2) EMC (1) ESC (2)	1	2.5-12/25

The furnaces share the support module and either two AC or ESC furnaces or the EMC furnace can be supported simultaneously.

Equipment physical characteristics were derived from Ref 1, Sections 6, 7, and 8. They are summarized in Table 1201-1.

Launch date and mission duration were derived.

Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 1201

PAYLOAD ELEMENT SYNTHESIS

TABLE 1201-1 EQUIPMENT PHYSICAL CHARACTERISTICS

PROCESS			ESSING DULE	SUP MODE		TOT	ALS
(QT)		MASS kg	VOLUME m3	MASS kg	VOLUME m3	MASS kg	VOLUME m3
AC EMC ESC	(2) (1) (2)	700 1460 700	2.0 4.8 2.0	1040	4.1	3,900	12.9

ORIGINAL PAGE 19 OF POOR QUALITY

		Page 1 of 3
PAYLOAD ELEMENT NAME Pilot - Furnace Proc Facility	CODE G D C D 1 2 O 2	
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division		Applications (non-commercial)
		X Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Tachnology Develorment
STATUS		
,	ato unity	Type Number 8
First flight, yr 1994 No. of flights Duration of Flight, days		(see Table A) Importance of the Space Station to
		this Eloment
Provide a moderate scale furnace processing facility for process development and optimization, and initial commercial output.	cial	1 = low value but could use 10 = vital
		Scale 1 - 10 10
DESCRIPTION This facility contains processing and support equipment for development of processes such as isothermal and gradient solidification, floating zone, vapor and solution crystal growth for the production of semiconductors, detectors, alloys, composites and single crystals.	equipment for develing zone, vapor and	lopment of processes such as solution crystal growth tes and single crystals.

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m	·		OF POOR QU	JALITY,	
CODE 6.0.0.1.2.0.2 Page 2 of	1 1 1 1	ING/ORIENTAT direction Sites (if k ing accuracy ing Stabilit	ac erating andby	MUNICATIONS ng requirements; \times	Data Types! Analog EDigital EHrs/Day 24 Film (Amount) Uoice (Hrs/Day) 1 Live TV (Hrs/Day) 0ther Other Orbit) Data Dump Frequency (Per Orbit) Downlink Frequency (MHZ)

ORIGINAL PAGE 19 OF POOR QUALITY

THERMAL
deg C.
Remote Unpressurize 75 H.m 445 Raw Mate
1 Task Assignment
Skills (See Table B) SKILL 5 5 5 1 LEVEL 2 3 Hrs/Day 2 2
EUA VES X NO Reason Hrs/EUA
Consumables,
Interval, day
lons

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GE	CD CODE	1202	ELEN	AENT NAME	PILOT	PRODUCTI	ON -	FURNA	CE I	<u>PROCE</u> SSING	3
ΑC	COMODA	TION: X	3 ATTACHED	☐ FRE	E FLYER	□ 0TV	OPS				
1.	STATION	ACTIVATIO	N (E.G., SET·U	P/ASSEMBLY	//ATTACH	MENT AND C	HECK	OUT)			
	DATE(S)	1994	INT. HRS _		EVA HR	S	EV/	A CREW_	-		
	□ NO.	T APPLICAB	 LE		•	·····		-			
2.	SERVICE	(E.G., REPL	ENISH/RESUPF	PLY)							
	INTERVA	AL0	AYS TOT	AL SERVICE	s						
	☐ TM	S/OTV REQU	JIRED		S	TATION HRS	PER S	ERVICE _			
	⊠ NO	T APPLICAB	LE		8	VA HRS PER	SERVI	ICE .			
					6	VA CREW SIZ	ZE				
3	STATION	OPERATIO	NAL SUPPORT	(AVG. TIME	FOR MON	ITOR. INSPEC	CT. ET	C.)			
•			DAY (INTERNA								
		HRS PER		HE, 20 GG	ys per						
		— HASTEN T APPLICAS									
		1 AFT LICAD	6.6								
4.		IGURATION									
	INTERVA	۱۲ ⁰	AYS TO	ITAL RECON		, ,					
	☐ TM:	S/OTV REQU	IIRED		S	TATION HRS	PER R	ECONFIG			
	☑ NO	T APPLICAS	LE		E	VA HRS PER	RECON	IFIG		 	
					E	VA CREW SIZ	Ε	-			
5.	DEACTIV	ATION/REM	IOVAL								
	DATE(S)	1997	INT. HRS		EVA HRS		EVA	CREW _			
	□ NO	T APPLICAB	LE -				•	عييه		<u> </u>	
6.	NOTES (BRIEFLY DE	SCRIBE TASKS	S IN 1 THROU	JGH 5 ABO	OVE)					
1.	rec Rep	w activi ord, loa air equi	on operat ty descri d/unload pment as ent opera	ption: samples, required	clean	out equi					

TOTAL EVA HRS 0

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 1202

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Pilot Production - Furnace Processing Facility

Reference Documents:

1. TRW Report .6-80-286, Vol. II, "MEC Payloads Handbook", 30 January 1981

Narrative:

This is a pilot production facility for several types of furnace processing process development and optimization, and for initial commercial output.

The facility contains processing and support modules as shown below:

Processing Module		Support Module	<u>Pwr, kw</u>
ASES HGDS	(2) (2)	1	2.5-12/25
FZ VCG SCG	(1)) (5)) (12)	1	2.5-30

Various combinations of furnaces can be run simultaneously, depending upon specimen sizes, but all furnaces cannot be run simultaneously.

Equipment physical characteristics were derived from Ref 1, Sections 3, 4, 5, 9, and 10. They are summarized in Table 1202-1.

Launch date and mission duration were derived.

Code: GDCD 1202 PAYLOAD ELEMENT SYNTHESIS

- 1. Description data for all attached payload elements is based upon MPS .6-80-286, Vol. II, MEC Payloads Handbook (TRW). All mass and volume values include a 25% growth factor.
- 2. Power levels shown are for the largest specimen sizes.
- 3. Abbreviations used are as follows:

AC Acoustic Containers ASES Advanced Solidification Experiment System BIO Biological CFE Continuous Flow Electrophoresis EMC Electromagnetic Containerless ESC Electrostatic Containerless FZ Floating Zone F/C Fluids/Chemistry HGDS High Gradient Directional Solidification IEF Isolectric Focusing SCG Solution Crystal Growth Stationary Electrophoresis Column SEC VCG Vapor Crystal Growth

4. The source data expresses equipment size in terms of volume rather than dimensions. In a manned laboratory the equipment would be packaged in equipment racks, or with dimensions similar to racks. Therefore, to derive the L by W by H dimensions required for the Payload Element Data Sheets, rack cross-sections of 2m high by 0.75m deep were assumed. The rack length was then calculated by: L = $\frac{V}{1.5}$ m

Page 3 of 3 Volume II, Book 1 Appendix I

Code: GDCD 1202

PAYLOAD ELEMENT SYNTHESIS

TABLE 1202-1 EQUIPMENT PHYSICAL CHARACTERISTICS

PROCESS			PROCESSING MODULE		SUP PORT MODUL E		TOTALS	
(01)		MASS kg	VOLUME m3	MASS kg	VOLUME m3	MASS kg	VOLUME m3	
ASES HGDS FZ	(2) (2) (1)	1082 1125 310	1.0 2.75 1.0	875	3.8	3,392	8.55	
VDG SCG	(5) (12)	410 288	1.2	362 T(1.3 DTAL	1060 4452 kg	3.5 12 ₃ 05 m3	

	Page 1 of 3
Commercial - Biol Proc Facility 6 0 c 0 1 2 0 3	•
	Applications (non-commercial)
San Diego, CA 92138	X Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Technology Development
STATUS	Operations
	Type Number 8
First flight, yr 1995 No. of flights 1825 Duration of Flight, days 1825	(see Table A) Importance of the Space Station to
	د
Provide full scale biological processing facility for commercial production of pharmaceuticals.	1 - low value but could use 10 - vital
	Scale 1 - 10 10
DESCRIPTION	
This facility contains processing and support equipment utilizing processes such as continuous flow and stationary column electrophoresis and isoelectric focusing, for the purification and separation of biologicals such as cells, proteins and hormones.	g processes such as continu- ocusing, for the purification es.

•	1 1 1 1				
0 3 Pege 2 of	! 1		☐ Continuous	(ZHII)	
CODE 6 D 1 2 0 3	Tolerance + Ephemeris Accuracy, m	DEarth s of view, deg	Duration, hrs/day 20 cy, Hz	Other Fraquency (MHZ).	Voice (Hrs/Day) 24 Uoice (Hrs/Day) 1 Other Downlink Frequency (MHZ)
	km >400 Toles	Solar [L Frequen	SOffline quired (KBS) Required	gite
	teristics >400 Periges, deg Any deg Any	ORIENTATION Sction Inertial (tos (if known) accuracy, arc sec Stability (Jitter)arc Astrictions (Avoidance	i i	rements! Realtime scryption Re Command Ration	ta Types: Analog XD1. Im (Amount) on TU (Hrs/Day) -Board Storage (MBIT) ta Dump Frequency (Per Orbit) cording Rate (KBPS)
	ORBIT CHARACTERIS Apogee, km >400 Inclination, deg Nodal Angle, deg Escape do Require	POINTING/ORIENTA Ulew direction Truth Sites (If Pointing accurac Pointing Stabili Special Restrict	9	DATA/COMMUNICATION Monitoring required None Encryption/Didink Req.: Son-Board Data Description	Data Tup Film (Am Cive Tu On-Board Data Dum

ORIGINAL PAGE 19 OF POOR QUALITY

•									
G D C D 1 2 0 3 Page 3 of 3	ational min 16,000 max 20,000 max 20,000	STICS Brnal Remote Saurized Unpressurized U, m .75 H, m .2. U, m .75 H, m .2. V, kg Types Cells, Proteins, Fluid	Task Assignment	2 2	Ars/Day 4 4 Ars/EUA	Consumables	day kg	lons	
	THERMAL MActive Passive Temperature, deg C operationa Heat Rejection, w operationa	EQUIPMENT PHYSICAL CHARACTERISTICS Location External Equipment ID/Function S.73 U, 5.73 U, L, m 5.73 U, L, mass, kg Consumables Type		Skills (See Table B) SKILL LEUEL	9	SERVICING/MAINTENANCE SERVICE:Interval, days Returnables	Int	SPECIAL CONSIDERATIONS/500 Inst. Vacuum vents are required.	

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

G	OCD CODE	1203	ELEMENT	AME_	COMMERC	IAL	BIOLOGICAL	.S PROCESSING	
ΑŒ	COMODA	TION: K	ATTACHED	FREE	FLYER		OTV OPS		
1.	STATION	ACTIVATION	(E.G., SET-UP/ASSE	MBLY.	/ATTACHM	ENT A	AND CHECKOUT)	
	DATE(S)	1995	INT. HRS		EVA HRS_		EVA CR	EW	
					-	•			
	☐ NO.	T APPLICABLE	E						
2.	SERVICE	(E.G., REPLE	NISH/RESUPPLY)						
	INTERVA	L DA	YS TOTAL SER	VICES	·	_			
	☐ TM	VOTV REQUI	RED		STA	ATION	HRS PER SERV	ICE	
	X NOT	APPLICABL	<u> </u>		EV	A HRS	PER SERVICE		
					EV	A CRE	W SIZE		
3.	STATION	OPERATION	AL SUPPORT (AVG.	TIME	OR MONIT	OR, 11	NSPECT, ETC.)		
	8	_HRS PER O	AY (INTERNAL) 26	day	s per m	onth	า		
		HRS PER D.	AY (EVA)						
	□ NO1	T APPLICABL	E						
4.	RECONFI	GURATION							
	INTERVA	L 0A	YS TOTAL RE	CONF	IGS		_		
	☐ TMS	VOTV REQUI	RED		STA	TION	HRS PER RECO	NFIG.	
	X NOT	APPLICABLE	•		EVA	HRS	PER RECONFIG	·	
					EVA	CRE	W SIZE		
5.	DEACTIV	ATION/REMO	IVAL						
	DATE(S)		INT. HRS.	1	EVA HRS _		EVA CRE	w	
					_				
	⊠ NO	APPLICABL	E						
6.	NOTES (B	RIEFLY DES	CRIBE TASKS IN 1 T	HROU	GH 5 ABOV	E)			
1. 3.	Crew produ prese Equip	icts, cle erve and oment ope		ent, s.	perfor Repair	m qu	ality cont	tion, load/unl rol checks, equired.	oad

TOTAL EVA HRS 0

AND THE PARTY OF STREET

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 1203

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Commercial Production - Biological Processing Facility

Reference Documents:

1. TRW Report MPS .6-80-286, Vol. II, "MEC Payloads Handbook", 30 January 1981

Narrative:

This is a commercial production facility for biological products.

The facility contains processing and support modules as shown below:

Proc	essing Module	Support Module	Pwr, kw
CFE SEC IEF	(20 Columns) (10 Columns) (20 Columns)	1	4-16/20

Multiple columns can be run in parallel, but all columns cannot be run simultaneously.

Equipment physical characteristics were derived from Ref 1, Section 11. They are summarized in Table 1203-1.

Launch date and mission duration were derived.

Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 1203

PAYLOAD ELEMENT SYNTHESIS

TABLE 1203 EQUIPMENT PHYSICAL CHARACTERISTICS

PRO	CESS		ESSING Dule	SUP!		TOT	ALS
(QT		MASS kg	VOLUME m3	MASS kg	VOLUME m3	MASS kg	VOLUME m3
BIO: CFE SEC IEF	(50) (20) (10) (20)	1340	4.2	760	4.4	2,100	8.6

	Page 1 of 3
PAYLOAD ELEMENT NAME Comml-Containerless Proc Facil	TYPE
/J. Peterson MZ 21-9530 Jynamics Convair Division	Applications (non-commercial)
Fig. 85357 San Diego, CA 92138	X Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Technology Development
STATUS Operational Planned Approved	
U0pportunity 1997	Type Number (See Table A)
No. of flights 1 1095+ Duration of Flight, days 1095+ OBJECTIVE	
Provide full scale containerless processing facility for commercial production of high value materials with superior properties.	com- 1 - low value but could use
	Scale 1 - 10 10
DESCRIPTION This facility contains processing and support equipment that utilize acoustic, electromagne and electrostatic containerless processing for the production of ultrapure glasses, alloys, ceramics and crystals.	ins processing and support equipment that utilize acoustic, electromagnetic ontainerless processing for the production of ultrapure glasses, alloys, lls.

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	ORBIT CHARACTERISTICS Apoges, km >400 Feriges, km >400 Tolerance + Inclination, deg Any Tolerance + Nodel Angle, deg Ephemeris Actived de Regulred.m/s	POINTING/ORIENTATION Usew direction Inertial Solar Earth Truth Sites (if known) Pointing accuracy, arc sec Field of view, Pointing Stabiling (Jitter) arc sec/sec	rating ndby k	UNICATIONS graduinements; \times \times \times \times 0 f \times	Data Types: Analog NDigital NHrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

ORIGINAL PAGE 19 OF POOR QUALITY

CODE Passive	C	7	5. 1 5 5	•	
C operational min non-operational min operational min operation operation operation operation operation operation operation operational min operation operation operation operation operation operations operational min operation	C. D. 1. 2. 0.4		2 2 2 ials, Gases	kg Raturnables,	
THERMAL MACL Temperature Heat Reject EQUIPMENT P Location! Equipment I CREU REQUIR Craw Size Skills (See Skills (See SKILLS (Int SERUICE Int SERUICE Int SERUICE Int SERUICE INT SPECIAL CON Vacuum vents	3	passive operational min operational min operational min non-operational min	PHYSICAL CHARACTERISTICS Internal External Remote ID/Function	Task Assignment SKILL SKILL LEUEL Hrs/Day Hrs/Day Hrs/Day Hrs/Day Consumables, ty turnables, kg turnables, kg Ton CHANGES:Interval, day Deliverables, kg Deliverables, kg Strinterval, day Task Assignment An 4 An 4 An 1000 Consumables, kg Deliverables, kg Deliverables, kg Strinterval, day Deliverables, kg Deliverables, kg Task Assignment An 4 An 1000 Tonsumables, kg Deliverables, kg Deliverables, kg Tonsumables, kg Deliverables, kg An 4 An An 4 An An 4 An An An 4 An An An 4 An An An 4 An An An 4 An An An 4 An An An 4 An An An 4 An An An 4 An An An 4 An An An 4 An An An 4 An An An 4 An An An An 4 An An An An An 4 An An An An An An An An An An An An An A	

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

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GO	CD COOE	1204	ELEMENT N	AME COMME	RCIAL CO	NTAINERLE	SS PROCE	<u>s</u> sing
AC	COMODATION:		CHED	FREE FLYER	□ 0TV (OPS		
1.	STATION ACTI	VATION (E.G.,	SET-UP/ASSE	MBLY/ATTACH	MENT AND C	HECKOUT)		
	DATE(S) 199	7 INT.	HRS	EVA HRS		_ EVA CREW		-
			-			_		_
	☐ NOT APP	LICABLE						
2.	SERVICE (E.G.,	REPLENISH/F	RESUPPLY)					
	INTERVAL	DAYS	TOTAL SER	VICES				
	☐ TMS/0TV	REQUIRED_		ST	TATION HRS	PER SERVICE		_
	⊠ NOT APP	LICABLE _		E	/A HRS PER	SERVICE		
				E,	VA CREW SIZ	ZE		_
3.	STATION OPER	RATIONAL SUI	PPORT (AVG. 1	TIME FOR MONI	TOR, INSPEC	CT, ETC.)		
				6 days per				
		S PER DAY (E)						
	☐ NOT APP							
	BECONCIOUS	TION						
4.	RECONFIGURA		TOTAL RE	CONFIGS.				
	☐ TMS/OTV		7017211			PER RECONFI	G.	
	☑ NOT APP					RECONFIG.		
	E NOT AFF	LICABLE		-	A CREW SIZ			_
				_ ·	A GILW SIL			-
5.	DEACTIVATIO							
	DATE(S)	INT.	HRS	EVA HRS		EVA CREW _		-
	⊠ NOT APP	LICABLE						
6.	NOTES (BRIEF	LY DESCRIBE	TASKS IN 1 T	HROUGH 5 ABO	VE)			
1.		operation		Mandhair	 	4	1 !	/vm1 nn d
3.	products	ivity des , clean o	cription: ut equipm	Monitor ent, perfo	equipmen rm quali	t operation	on, load 1 checks	/unioad , package
	products	. Repair	equipmen	t as requi hours per	red.	-		. •
5.		s after y			au, .			

TOTAL EVA HRS ____

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Code: GDCD 1204

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Commercial Production - Containerless Processing Facility

Reference Documents:

1. TRW Report MPS .6-80-286, Vol. II, "MEC Payloads Handbook", 30 January 1981

Narrative:

This is a commercial production facility using containerless processing.

The facility contains processing and support modules as shown below:

Processing Module	Support Module	<u>Pwr, kw</u>
AC (3) EMC (1) ESC (3)	1 1	26 12 26 26/38

Each type of processing module can be run simultaneously. Chambers can be run simultaneously for small specimens, and singly for large specimens.

Equipment physical characteristics were derived from Ref 1, Section 6, 7, and 8. They are summarized in Table 1204-1.

Launch date and mission duration were derived.

Code: GDCD 1204

PAYLOAD ELEMENT SYNTHESIS

- 1. Description data for all attached payload elements is based upon MPS .6-80-286, Vol. II, MEC Payloads Handbook (TRW). All mass and volume values include a 25% growth factor.
- 2. Power levels shown are for the largest specimen sizes.
- 3. Abbreviations used are as follows:

AC	Acoustic Containers
ASES	Advanced Solidification Experiment System
BIO	Biological
CFE	Continuous Flow Electrophoresis
EMC	Electromagnetic Containerless
ESC	Electrostatic Containerless
FZ	Floating Zone
F/C	Fluids/Chemistry
HGDS	High Gradient Directional Solidification
IEF	Isolectric Focusing
SCG	Solution Crystal Growth
SEC	Stationary Electrophoresis Column
VCG	Vapor Crystal Growth

4. The source data expresses equipment size in terms of volume rather than dimensions. In a manned laboratory the equipment would be packaged in equipment racks, or with dimensions similar to racks. Therefore, to derive the L by W by H dimensions required for the Payload Element Data Sheets, rack cross-sections of 2m high by 0.75m deep were assumed. The rack length was then calculated by: $L = \frac{V}{T.5}$ m

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Code: GDCD 1204

PAYLOAD ELEMENT SYNTHESIS

TABLE 1204-1 EQUIPMENT PHYSICAL CHARACTERISTICS

PROCESS		PROCESSING MODULE		SUP PORT MODULE		TOTALS	
(QTY		MASS kg	VOLUME m3	MASS kg	VOLUME m3	MASS kg	VOLUME m3
AC EMC ESC	(3) (1) (3)	1100 1460 1100	3.4 4.8 3.4	500 1040 500 T(2.3 4.1 2.3 DTAL	1,600 2,500 1,600 5,700 kg	5.7 8.9 5.7 20.3 m3

	Page 1 of 3
PAYLOAD ELEMENT NAME Comm-Furnace Proc Facility 6 0 0 0 1 2 0 5	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division	Applications (non-commercial)
Hadross P.O. Box 85357 San Diego, CA 92138	X Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Technology Development
STATUS	Operations
,	Type Number 8
First flight, yr 1997 No. of flights 1 Duration of Flight, days 1460+	(see Table A) Importance of the Space Station to
	this Element
Provide full scale furnace processing facility for commercial production of high value materials with superior properties.	1 - low value but could use 10 - vital
	Scale 1 - 10 10
DESCRIPTION	
This facility contains processing and support equipment that utilize isothermal and gradient solidification, floating zone, vapor and solution crystal growth processes, for the production of semiconductors, detectors, alloys, composites and single crystals.	lize isothermal and gradient processes, for the productorystals.

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CODE 6.0 c. p. 1.2.0 5	70,000	2 2 rrials, Gas 0-5	Hrs/EUA kg Raturnables, kg	
Ö	THERMAL	S Remote ized Unpressur. 1	Task Assignment 5 5 5 8 4 4 Consumables, Man Hours day tructions	

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

G	DCD CODE 1205 EL	EMENT NAMECOMM!	RCIAL FURNACE PRO	DCESSING
AC	CCOMODATION: 🖸 ATTACHE	D	OTV OPS	
1.	STATION ACTIVATION (E.G., SET	UP/ASSEMBLY/ATTACH	MENT AND CHECKOUT)	
	DATE(S) 1997 INT. HRS	EVA HRS	EVA CREW	·
	☐ NOT APPLICABLE			
2.	SERVICE (E.G., REPLENISH/RESU	PPLY)		
	INTERVAL DAYS TO	TAL SERVICES		
	TMS/OTV REQUIRED	s	TATION HRS PER SERVICE	
	X NOT APPLICABLE		VA HRS PER SERVICE	
		Ε	VA CREW SIZE	
3.	STATION OPERATIONAL SUPPOR	T (AVG. TIME FOR MON	ITOR, INSPECT, ETC.)	
	8 HRS PER DAY (INTER	NAL) 26 days per	month	
	HRS PER DAY (EVA)	• .		
	☐ NOT APPLICABLE			
4	RECONFIGURATION			
٧.	INTERVAL DAYS 1	OTAL RECONEIGS		
	TMS/OTV REQUIRED		TATION HRS PER RECONFI	ıc
	■ NOT APPLICABLE	-	A HRS PER RECONFIG.	
	-		A CREW SIZE	
			A GREW SIZE	
5.	DEACTIVATION/REMOVAL			
	DATE(S) INT. HRS.	EVA HR\$	EVA CREW	
	_		 .	
	☑ NOT APPLICABLE			
6.	NOTES (BRIEFLY DESCRIBE TASI	S IN 1 THROUGH 5 ABO	VE)	
1. 3.	Crew activity descriproducts, clean out of products. Repair equipment operations	equipment, perfo Jipment as requi Ses 24 hours per	rm quality contro red.	on, load/unload l checks, package

TOTAL EVA HRS 0

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 1205

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Commercial Production - Furnace Processing Facility

Reference Documents:

1. TRW Report MPS .6-80-286, Vol. II, "MEC Payloads Handbook", 30 January 1981

Narrative:

This is a commercial production facility using several types of furnace processing.

The facility contains processing and support modules as shown below:

Processin	ng Module	Support Module	Pwr, kw	
ASES HGDS FZ VCG SCG ((4) (4) (2) (5) (12)	1 1 1 1	2-24 2.5-40 4-40 2.5-30 1.5-14	40/70

Each type of processing module can be run simultaneously. Funaces can be run simultaneously for small specimens, and in various combinations for large specimens.

Equipment physical characteristics were derived from Ref 1, Section 3, 4, 5, 9, and 10. They are summarized in Table 1205-1.

Launch date and mission duration were derived.

Page 2 of 3 Volume II, Book 1 Appendix I

Code: GDCD 1205

PAYLOAD ELEMENT SYNTHESIS

- 1. Description data for all attached payload elements is based upon MPS .6-80-286, Vol. II, MEC Payloads Handbook (TRW). All mass and volume values include a 25% growth factor.
- Power levels shown are for the largest specimen sizes.
- 3. Abbreviations used are as follows:

Acoustic Containers AC **ASES** Advanced Solidification Experiment System BIO Biological CFE Continuous Flow Electrophoresis **EMC** Electromagnetic Containerless ESC Electrostatic Containerless FΖ Floating Zone F/C Fluids/Chemistry High Gradient Directional Solidification HGDS IEF Isolectric Focusing SCG Solution Crystal Growth Stationary Electrophoresis Column SEC Vapor Crystal Growth VCG

4. The source data expresses equipment size in terms of volume rather than dimensions. In a manned laboratory the equipment would be packaged in equipment racks, or with dimensions similar to racks. Therefore, to derive the L by W by H dimensions required for the Payload Element Data Sheets, rack cross-sections of 2m high by 0.75m deep were assumed. The rack length was then calculated by: $L = \frac{V}{1.5}$ m

Page 3 of 3 Volume II, Book 1 Appendix I

Code: GDCD 1205

PAYLOAD ELEMENT SYNTHESIS

TABLE 1205-1 EQUIPMENT PHYSICAL CHARACTERISTICS

PROCESS			ESSING DULE	SUP I Modu		тот	ALS
(QT)	()	MASS kg	VOLUME m3	MASS kg	VOLUME m3	MASS kg	VOLUME m ³
ASES HGDS FZ VGC SCG	(4) (4) (2) (5) (12)	1512 1425 535 410 288	2.6 3.65 1.7 1.2 1.0	238 875 440 240 362	3.8 3.55 2.5 1.3 1.2 DTAL	1,750 2,300 975 650 650 6,325 kg	6.4 7.2 4.2 2.5 2.2 22.5 m ³

	Page 1 of
FHYLUMD ELEMENT NAME Electrophoresis Free-Flyer	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division	Applications (non-commercial)
San Diego, CA 92138	X Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Technology
nal	Operations
☐ Approved ☐ Candidate ☐ Opportunity	Type Number 8
ght, yr 1986 ights 5 of Flight, days 182	
OBJECTIVE To begin near-term commercial manufacturing of pharmaceutical	ديد
products.	1 = low value but could use 10 = vital
	Scale 1 - 10 6
DESCRIPTION	
The electrophoresis operations in space (EOS) free-flyer consists of a production module, resupply module and a support bus such as a leasecraft. Five such vehicles are planned launched one per year. Initial operations will be Shuttle supported.	s of a production module, a ch vehicles are planned rted.

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6					
G D C D 1 2 0 6 Page 2 of 3	Tolerance + Tolerance + Ephemeris Accuracy, m	☐Solar ☐EarthField of view, deg	U Duration, hrs/day	Ins Other Frequency (MHZ)	Digital Hrs/Day Voice (Hrs/Day) Other bit) Downlink Frequency (MHZ)
	ORBIT CHARACTERISTICS Apogae, km >400 Perigee, km >400 Inclination, deg Any Nodal Angle, deg	ENTATION On Inertial (If known) uracy, arc sec billty (Jitter) arc	OUER AC DC Power, Operating Standby Peak	DATA/COMMUNICATIONS Monitoring requirements: None None Encryption/Decryption Required Numblink Req.: Command Rate (KBS) NOn-Board Data Processing Required Description	Data Types! Analog Dig Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

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C)	OF POOR C	QUALITY	•
CODE 6.0 C. D. 1 2 0 6 Page 3 of	THERMAL Active Passive	rics rnal Remote surizedKUnpressurized U,m 4.27 H,m 4.27 U,m H,m 9.987 Types	CREW REQUIREMENTS Crew Size Crew Size Skills (See Table B) EUEUE EUA	This free-flyer is typical of others that may be utilized for other types of materials process- ing such as crystal growth.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GOCD CODE 1206 ELEMENT NAME ELEC	CTROPHORESIS FREE-FLYER
ACCOMODATION: ATTACHED THE FLYE	ER 🔲 OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	CHMENT AND CHECKOUT)
DATE(S) 1990* INT. HRS EVA	HRS EVA CREW
□ NOT APPLICABLE *Last activation sh	total of 5)
2. SERVICE (E.G., REPLENISH/RESUPPLY) for each	•
INTERVAL 180 DAYS TOTAL SERVICES	
TMS/OTVX960URRER_ALTERNATE	STATION HRS PER SERVICE24
□ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR M	IONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONFIGS.	
☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) 1995* INT. HRS EVA H	IRS EVA CREW
NOT APPLICABLE *Last deactivation 6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	shown (1 per year starting in 1991, total of 5)
This payload element has orbit transfe	
 and 5. Station operations Free flyers will be serviced at Space Logistics modules will be exchanged. The support bus will have propellant required) will be by module replaced No EVA is planned for servicing. EVA may be required for contingency. 	using an RMS-type manipulator. replenished and repair (if ment.

TOTAL EVA HRS 0

Code: GDCD 1206

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Electroporesis Free-Flyer

Reference Documents:

1. "System Requirements for Baseline Materials Processing in Space Payloads (System Requirements Document)", Document No. SP81-MSFC-2535, June 1981. Prepared by Teledyne Brown Engineering.

2. "Fairchild Leasecraft System", briefing presented on 11 Nov. 1982 at GDC (Document No. GDC 20-003).

Narrative:

This payload consists of an Electrophoresis Operations in Space (EOS) production plant coupled to a Leasecraft support bus. The production plant will consist of Factory and Resupply modules.

The EOS Resupply Module (EOS-RM) provides a means of transporting new materials (up) and product (down). The EOS Factory Module (EOS-FM) remains on orbit with the support bus for periods of 5 years with the EOS-RMs being exchanged at 6-month intervals.

The Leasecraft bus has an augmented power subsystem capable of continuously supplying 3500 watts to the EOS production plant.

Mass properties for the EOS Free-Flyer are given in Table 1206-1.

Equipment characteristics for the FOS production plant were obtained from Ref 1, Sections 4.3 and 5.3.

Leasecraft characteristics were obtained from Ref 2.

Code: GDCD 1206

PAYLOAD ELEMENT SYNTHESIS

Table 1206-1. Electrophoresis Free-Flyer Mass Summary

ELEMENT	MASS				
CL EPICH (16	kg			
Factory Module(1)	5,000.	2,268.			
Resupply Module - Up(1)	5,000.	2,268.			
(Resupply Module - Down)(1)	(4,700)	(2,132)			
Leasecraft Dry Weight(2)	6,000.	2,722.			
Total propellants ⁽²⁾	6,000.	2,722.			
(Useable propellants -95%)(3)	(5,700)	(2,586)			
Launch Weight - Fully Loaded	22,000.	9,979.			

NOTES:

- (1) Ref 1, pp 4-15
- (2) Ref 2
- (3) GDC estimate

Initial EOS launch in 1986 is from MDAC/Fairchild preliminary planning. Five free-flyers will be launched and supported by the shuttle between 1986 and 1990. Support can be taken over by the Space Station in 1990, or whenever convenient to phase in.

This payload will be shuttle supported during the initial operating period. For Space Station supported operaztions, the Leasecraft bus will return the payload to the station, periodically and the resupply module will be exchanged by a space station provided RMS.

- 1			Page 1 of
PAYLOAD ELEMENT NAME Electrophoretic Separation	ME ition	CODE 6 D C D 1 2 0 7	
CONTACT W. Hardy/J. I	W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division		Applications (non-commercial)
San Diego, CA 92138	.A 92138		X Commercial
Telephone (619) 277-8900, Ext.	00, Ext. 3778/2130		Technology Development
STATUS 0 perational 0 Approved	☐ Planned ※ Candidate	ined	
First flight, yr 1	1990 — Oppo	Opportunity	Type Number (see Table A)
Duration of Flight, OBJECTIVE	days 7		552
Purification of biomaterials.	erials.		1 = low value but could use 10 = vital
			Scale 1 - 10 8
1	-		
Research leading to the to those developed by P GDCD 0400 Research and	the development of elec by McDonnell Douglas. and Development facility	the development of electrophoretic purification methods complem by McDonnell Douglas. and Development facility could accommodate this payload segment.	the development of electrophoretic purification methods complementary by McDonnell Douglas. Ind Development facility could accommodate this payload segment.

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m			OF POUR Q	UALITY.	
CODE 6 D C D 1 2 0 7 Pege 2 of 3	Periges, km Any Tolerance + Any Tolerance + Ephemeris Accuracy, m	POINTING/ORIENTATION Usew direction Inertial Solar Earth Truth Sites (if known) Fruth Sites (if known) Pointing accuracy, arc sec Field of view, deg Pointing Stability (Jitter) arc sec/sec		nitoring requirements: Intering requirements: None Realtime Of Encryption/Decryption Requirement Requirement Requirement Reto (KI On-Board Data Processing Requirement Description	Data Types: Analog XDigital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

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Page 3 of 3	111	و د د و	xp. 0ps.					3) ng	
6 D C D 1 2 0 7 Pa		Stowed Deployed	Control Preprogrammed Exp. Ops				Roq.	ontamination. involve livi	
CODE					Hrs/EUA	1	Man/Hrs Roq.	emit gaseous c torage. 4) Can	
	11 ul	urized Dapressurize U, m 1.0 - 1.4 H, m 1. U, m kg kg		5 2	1 <0.5	Consumbles,	kg	PECIAL CONSIDERATIONS/500 Instructions 1) Can tolerate up to 10 ⁻² g transient acceleration. 2) May emit gaseous contamination. 3) Requires refrigerator, freezer, tissue culture facilities storage. 4) Can involve living cells in tissue culture.	
•	ational m ational m ational m	CTERISTICS External Pressurized 1.0-1.4 U,m 1 W.m 1 h mass, kg mables Types	1	SKILL LEVEL	Hrs/Day Reason		Interval, day Deliverables, k	SPECIAL CONSIDERATIONS/500 Instructions 1) Can tolerate up to 10^{-2} g transient accelerati Requires refrigerator, freezer, tissue culture f cells in tissue culture.	
·	C Pas	ARP Inc	1 1	(B	X NO Re	4.6	CHANGES I Interval. Deliverab	NTIONS/500 to 10 ⁻² g trans or, freezer, t ture.	
	THERMAL Mactive Temperature, deg Heat Rejection, w		REQUIREMENTS Size	Skills (See Table	□ ves	SERVICING/MAINTENANCE SERVICE: Interval, day Returnables	RATION CHE	DECIAL CONSIDERATI(1) Can tolerate up to 1 Requires refrigerator, cells in tissue culture	
	THERMAL []Active Temperature, Heat Rejective	EQUIPMENT Location: Equipment	CREU RE	Skills	EUA	SERVICI SERVICE	CONFIGURATION	SPECIAL 1) Can Require cells i	

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GDC-ASP-83-002

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GE	DCD CODE 1207 ELEMENT NAME	ELECTROPHORETIC SEPARATION
AC	CCOMODATION: 🛛 ATTACHED 🔲 FREE F	LYER OTV OPS
1.	STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/A DATE(S) 1990 INT. HRS E	
	□ NOT APPLICABLE	
2.	SERVICE (E.G., REPLENISH/RESUPPLY)	
	INTERVAL DAYS TOTAL SERVICES _	
	TMS/OTV REQUIRED	STATION HRS PER SERVICE
	■ NOT APPLICABLE	EVA HRS PER SERVICE
		EVA CREW SIZE
	STATION OPERATIONAL SUPPORT (AVG. TIME FO O.5 HRS PER DAY (INTERNAL) HRS PER DAY (EVA) NOT APPLICABLE RECONFIGURATION	R MONITOR, INSPECT, ETC.)
	INTERVAL DAYS TOTAL RECONFIG	S
	TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
	☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
		EVA CREW SIZE
5.	DEACTIVATION/REMOVAL	•
	DATE(S) INT. HRS EV	A HRS EVA CREW
	■ NOT APPLICABLE	
6.	NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH	S ABOVE)
	and 5. Accommodated in - 0400 fa Seven day mission crew tasks: N record, load/unload samples, pre are not additive to -0400 crew t	donitor, control/manipulate, measure/ serve and store samples. Crew tasks

TOTAL EVA HRS 0

.

Code: GDCD 1207

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Electrophonetic Separation .

Reference Documents:

1. University of Arizona, Biophysics Technology Laboratory, User Fac+ Sheet

Narretive:

The data was primarily from Ref 1. The objective is the purification of biomaterials using electrophonetic purification methods complimentary to those developed by MDAC. Association of this payload element with accommodating payload (GDCD 0400) was developed through visit to General Dynamics.

	Page 1 of 3
Space Mfg of Electronic Mtls 6 0 c 0 1 2 0 8	
n MZ 21-9530 nvair Division	Applications (non-commercial)
San Diego, CA 92138	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Tachnology
STATUS Operational Planned Approved	Operations
000	Type Number 8
ght, yr 1992 1ghts 1 of Flight, days 6.5	Importance of the Space Station to
UBJECTIVE To produce very high quality gallium arsenide and other electronic crystals in space to meet market requirements.	
	10 - vital
	Scale 1 - 10 8.
GDCD 0400 Research and Development facility could accommodate this payload element. Sour data for a Shuttle based payload is SP81-MSFC-2517 accommodations assessment or on-orbit, commercial growth of single crystals, March 1981.	s payload element. Source assessment or on-orbit,

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.		OF	POOK GOVERS		
CODE 6.0.0.1.2.0.8 Page 2 of 3	km Any Tolorance + Tolorance + Ephemeris Accuracy, m	NG/ORIENTATI Irection Sites (If kr ng accuracy, ng Stability	ratingk	MUNICATIONS ng requirements! Realtime Of Ption/Decryption Requirent Requirement Requirent Requirement Requirent Command Reteront Requirement Reteront Requirement Reteront Requirement Reteront Requirement Reteront Requirement Reteront Requirement Reteront Reteront Reteront	Data Types: Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

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CODE G.D.C.D.1.2.08	•
Passive	
non-operational min operational min	
EQUIPMENT PHYSICAL CHARACTERISTICS Location: OInternal ORemote Equipment ID/Function OPressurized Unpressurized	
1 1	
IREMENTS	
Skills (See Table B) SKILL	
EUA VES NO Reason Hrs/EUA	Т
samples,	11
day Man Hours Man/Hrs Rog.	F
kg Returnah Ions	-11
Orbits of maximum sunlight desired for high energy demand furnaces to be utilized.	

GDC-ASP-83-002

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 1208 ELEMENT NAME CRYSTAL GROWTH
ACCOMODATION: MATTACHED THE FLYER TOTO OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)
DATE(S) 1992 INT. HRS EVA HRS EVA CREW
□ NOT APPLICABLE
2. SERVICE (E.G., REPLENISH/RESUPPLY)
INTERVAL DAYS TOTAL SERVICES
TMS/OTV REQUIRED STATION HRS PER SERVICE
■ NOT APPLICABLE EVA HRS PER SERVICE
EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)
HRS PER DAY (EVA)
NOT APPLICABLE
4. RECONFIGURATION
INTERVAL DAYS TOTAL RECONFIGS
☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG.
■ NOT APPLICABLE EVA HRS PER RECONFIG.
EVA CREW SIZE
5. DEACTIVATION/REMOVAL
DATE(S) 1992 INT. HRS EVA HRS EVA CREW
NOT APPLICABLE
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)
 and 5. are accommodated in -0400 facility Operations of this 6.5 day mission are accounted for in -0400

TOTAL EVA HRS 0

Code: GDCD 1208

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Crystal Growth

Reference Documents:

1. Micro Graving Research Associates, User Fact Sheet

Narrative:

The data was primarily from Ref 1. The mission objective is to produce very high quality gallium arsenide and other electronic crystals in space. MRA currently has a JEA in final stages of coordination at NASA headquarters.

The relationship of this payload element with accommodating payload (GDCD 1202), was derived from association of payload objectives and requirements.

- 1		Page 1 of 3
PAYLOAD ELEMENT NAME Metal Clusters and Crystal Growth	CCDE G D C D 1 2 0 9	
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division Address P. D. B. SESET		Applications (non-commercial)
San Diego		X Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Technology Develorment
na l		Operations
	Candidate	Type Number 8
First flight, yr 1990 No. of flights 1 Duration of Flight, days 15		(see Table A) Importance of the Space Station to
		دب
Ose space to carry out reaction in a convection-free environment.	on-tree	1 - low value but could use 10 - vital
•		Scale 1 - 10 8
DESCRIPTION		
Perform metal cluster chemistry and growth of organic and inorganic crystals in space. GDCD 0400 research and development facility could accommodate this payload element.	f organic and inorgar could accommodate thi	nic crystals in space. is payload element.

and a start of the start to

6 0 C 0 1 2 0 9 Page 2 of 3	Hecuracy, m	urth view, deg	hrs/day □ Continuous	Frequency (MHZ)	o/Day s/Day) or Frequency (MHZ)
CODE 6,0	ORBIT CHARACTERISTICS Apogee, km Any Periges, km Any Tolerance + Inclination, deg Any Tolerance + Nodel Angle, deg Ephemeris Accuracy	sec Solar Earth Sec Field of view, tter)arc sec/sec	POWER POWER Operating 500 - 1000 Standby Peak Voltage, V	MUNICATIONS ng requirements! Realtime Offline Other yption/Decryption Required nk Req.iCommand Rate (KBS) oard Data Processing Required ription lay/keyboard and general purpose computer.	Data Types! Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

X d B X d B	Surizo H, m H, m	R min max 10-4 Preprogrammed & Realtime Exp	Ables, kg		IONS/Spe Instructions ulate and gaseous contaminations and may be sensitive to RF/magnetic crystals and chemical samples is provided. 3) Resupply/return to Earth 4) Can involve up to 10-2g transient acceleration.
THERMAL Active Passive Temperature, deg C operational min Heat Rejection, w operational min non-operational min	rics rnal surized U,m (Lu,m (Acceleration sensitivity, I Task Assignme	SERVICING/MAINTENANCE SERVICE:Interval, days Returnables	CONFIGURATION CHANGES Interval, day Deliverables, kg	JECINIC CONSIDERRATIONS/See Instructions 1) Sensitive to particulate and gaseous contaminations and may be sensitive to RF/magnetic fields. 2) Storage for crystals and chemical samples is provided. 3) Resupply/return to Ean of materials/samples. 4) Can involve up to 10- ² g transient acceleration.

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE1209	ELEME	NT NAME	METAL	CLUSTER	& CRYSTAL	GROWTH
ACCOMODATION: 8						
1. STATION ACTIVATIO	N (E.G., SET-UP/	ASSEMBLY	/ATTACHM	ENT AND CH	ECKOUT)	
DATE(S) 1990	INT. HRS		EVA HRS		EVA CREW_	
-						
NOT APPLICAB	LE					
2. SERVICE (E.G., REPL	ENISH/RESUPPL	Y)				
INTERVALD						
TMS/OTV REQU	IIRED		ST	ATION HRS P	ER SERVICE _	
M NOT APPLICAB	LE		EV	A HRS CER S	ERVICE _	
			ΕV	A CREW SIZE	-	
3. STATION OPERATION	NAL SUPPORT (#	AVG. TIME	FOR MONI	TOR, INSPECT	, ETC.)	
1 HRS PER	DAY (INTERNAL	.)				
HRS PER						•
□ NOT APPLICAB	LE	•				
4. RECONFIGURATION						
INTERVAL	AYS TOTA	AL RECONI	FIGS			
☐ TMS/OTV REQU					R RECONFIG.	
✓ NOT APPLICAB	- -				ECONFIG	
<u> </u>	10-10			A CREW SIZE		
					_	
5. DEACTIVATION/REM						
DATE(S) 1990	INT. HRS		EVA HRS _		EVA CREW	
			-		_	
☐ NOT APPLICAS	LE					
6. NOTES (BRIEFLY DE	SCRIBE TASKS	N 1 THROU	GH 5 ABO	/E)		
and 5. are acc This is a 15 manipulation out equipment	day missio , measureme t, unpack a	n. Cre nt/reco nd pack	w tasks rd, loa age sam	are: mor d/unload ples for	samples, earth ret	clean

TOTAL EVA HRS 0

Code: GDCD 1209

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Metal Crystals and Crystal Growth

Reference Documents:

1. 3M Company, User Fact Sheet

Narrative:

The data was from REf 1. The mission objective is to perform metal cluster chemistry and grow organic and inorganic crystals in a convection-free environment.

The relationships of this payload element with accommodating payload (GDCD 0400) was derived based on association of objectives and requirements.

		Page 1 of
PAYLOAD ELEMENT NAME Enzymes	CODE G D C D 1 2 1 0	
terson MZ 21-9530 cs Convair Division		Applications (non-commercial)
San Diego, CA 92138		X Commercial
Telephone (619) 277-8900, Ext. 3778/2130		☐ Technology Development
SIATUS Operational Operate Approved Scandidate	10 to to to to to to to to to to to to to	Operations
	unity	Type Number 8
First flight, yr 1990 No. of flights 1 Duration of Flight, days <4 OBJECTIVE		(see Table A) Importance of the Space Station to this Element
Enzyme production and/or separation.		1 = low value but Could use 10 = vital
	7,1,1,4	Scale 1 - 10 8
DESCRIPTION User identifies payload element description as proprietary. GDCD 0400 research and development facility could accommodate this payload element.	proprietary.	s payload element.

CODE 6 D C D 1 2 1 0 Page 2 of 3		☐Solar ☐EarthField of view, deg	U Duration, hrs/day	Other Frequency (MHZ)	X Digital
	ORBIT CHARACTERISTICS Apogee, km Any Perigee, km Inclination, deg Any Nodal Angle, deg	POINTING/ORIENTATION Usew direction Truth Sites (If known) Pointing accuracy, arc sec Pointing Stability (Jitter) arc	OUER GAC Operating Standby Peak	DATA/COMMUNICATIONS Monitoring requirements: None Encryption/Decryption Required Uplink Req.: Command Rate (KBS) Up-Board Data Processing Required Description Digital and analog tape recorders	r Or

CODE 6.0.0.1.2.1.0	Page 3 of 3	r
# 1 m		<u> </u>
north a oberational		
EQUIPMENT PHYSICAL CHARACTERISTICS Location: OInternal OExternal ORamota Equipment ID/Function OPressurizedOUnpressurized		
E.T	Stowed Deployed	
IREMENTS		
Craw Size 1 Real Time Active Control	ontrol	
5		
Hrs/Day 2.0		
EUA TYES XINO Reason Hrs/EUA		
EKUICE Incorval, days Deturnables, kg		
Interval, day		
Returna		
1) May need airlock and view port. 2) May be sensitive to gaseous and particulate contamina-	ontamina~	
eron, radioactivity and Kr/Magnetic fields. 3) Logistic resupply and sample/product return to Earth. 4) Refrigeration required for sample's products. 5) Living micro-organisms are used	return to	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

G	GOCD CODE 1210 ELEMENT NAME	E ENZYME PRODUCTION AND SEPARATION
A(ACCOMODATION: X ATTACHED - FR	EE FLYER
1.	1. STATION ACTIVATION (E.G., SET-UP/ASSEMBL	Y/ATTACHMEN AND CHECKOUT)
	DATE(S) 1990 INT. HRS	EVA HRSEVA CREW
	□ NOT APPLICABLE	
2.	2. SERVICE (E.G., REPLENISH/RESUPPLY)	·
	INTERVAL DAYS TOTAL SERVICE	ES
	TMS/OTV REQUIRED	STATION HRS PER SERVICE
	☑ NOT APPLICABLE	EVA HRS PER SERVICE
		EVA CREW SIZE
3.	3. STATION OPERATIONAL SUPPORT (AVG. TIM	E FOR MONITOR, INSPECT, ETC.)
	2 "9S PER DAY (INTERNAL)	
	HRS PER DAY (EVA)	
	☐ NOT APPLICABLE	
4.	4. RECONFIGURATION	
	INTERVAL DAYS TOTAL RECO	NFIGS.
	TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
	☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	•	EVA CREW SIZE
5.	5. DEACTIVATION/REMOVAL	
	DATE(S) 1990 INT. HRS.	EVA HRS EVA CREW
	☐ NOT APPLICABLE	
6.	6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THRO	DUGH 5 ABOVE)
	recording, load/unload sample	00 facility w tasks are: monitoring, measurement, s, preserve and store samples. unpack return. Crew tasks are not additive

TOTAL EVA HRS 0

Code: GDCD 1210

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Enzyme Production and Separation

Reference Documents:

1. A.E. Staley Mfg. Co., User Fact Sheet

Narrative:

The data was primarily from Ref 1. The mission involves fermentation of microorganism producing a useful enzyme and/or separation of enzyme constituents from broth. The association of this payload element with accommodating payload (GDCD 0400) was derived bas d on association of payload objectives and requirements.

PAYLOAD ELEMENT NAME	7000	Page 1 of
٠,—	6 D C D 1 2 1 1	
CONTACT W. Hardy/J. Peterson MZ 21-9530 Name General Dynamics Convair Division Address P. D. R. BESET		Applications (non-commercial)
San Dieg		X Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Technology Development
STATUS Operational Planned	ned	Operations
	Opportunity	
First flight, yr 1990 No. of flights 1 Duration of Flight, days 30 OBJECTIVE		(See Table A) Importance of the Space Station to this Element
To produce dislocation-free silicon ingots with uniform and homogenous properties, both with respect to dopant distributions and to micro-defect incorporation.	with uniform and dopant distribu-	1 = low value but could use 10 = vital
		Scale 1 - 10 10
DESCRIPTION		
Payload element proposes the growth of 25 to 50 mm diameter, 30 cm length dislocation-free silicon crystals in a low gravity environment. The growth method is to be floating zone possibly in a mirror furnace. One crystal could be grown in about 8 hours. Additional runs would require disassembly, cleaning and setup. All reassembly of furnace in orbit. Ref. GDCD 0400 research and development facility could accommodate this payload element.	to 50 mm diameter, 30 sent. The growth method tould be grown in about setup. All reassem:ility could accommoda	poses the growth of 25 to 50 mm diameter, 30 cm length dislocation-free is a low gravity environment. The growth method is to be floating zone in furnace. One crystal could be grown in about 8 hours. Additional disassembly, cleaning and setup. All reassembly of furnace in orbit. earch and development facility could accommodate this payload element.

CODE 6.0 C.0 1.2.1.1 Page 2 of 3	ERISTICS ny Periges, km Any Tolerance + deg Any Tolerance + deg Ephereris Accuracy, m	ORIENTATION Section Distral Solar Dearth		i	Frequency, Hz	MUNICATIONS Ag requirements: 00ffline 0ther		·iption lapse photography during crystal growth - up to 8 hrs/run.	Types: Analog Digital Hrs/Day (Amount)	Day)	Dump Freques
	ORBIT CHARACTERI Apogee, km Any Inclination, deg Nodel Angle, deg Escane do Requir	POINTING/ORIENTAT	Pointing accuracy Pointing Stabili Special Restrict		Peak Voltage, U	DATA/COMMUNICATIONS Monitoring requirem INone	Encryption/D Uplink Req.:	Description Time-lapse pho	Data Types! Film (Amount)	TU	Dear

	G D C D 1 2 1 1 Page 3 of 3
THERMAL MActive Passive Temperature, deg C operational min non-operational min Heat Rejection, w operational min non-operational min	
EQUIPMENT PHYSICAL CHARACTERISTICS Location: XInternal External Remote Equipment ID/Function XPressurized Unpressurized L,m 0.8 U,m 0.75 H,m L,m 0.8 U,m 0.75 H,m Launch mass, kg Consumables Types Consumables Types	ad 2.0 Stowed 2.0 Deployed 300
Task Assignment	5 5
oc Tablo B) SKILL LEVEL Hrs/Da	
EUA YES X NO Reason	Hrs/EUA
SERVICING/MAINTENANCE SERVICE:Interval, days Returnables, kg 0.4 - 1.5 per run Man Hours CONFIGURATION CHANGES:Interval, day Deliverables, kg	
	diameter crystal for each run; n energy is required. 3) May RF/Magnetic field; 4) Can tol- n isolation. 6) Duration based

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PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GE	OCD CODE 1211 ELEMENT NAME SIL	ICON CRYSTALS
ΑC	COMODATION: 🗷 ATTACHED 🗌 FREE FLY	YER OTV OPS
1.	STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	ACHMENT AND CHECKOUT)
	DATE(S) 1990 INT. HRS EVA	HRS EVA CREW
	☐ NOT APPLICABLE	
2.	SERVICE (E.G., REPLENISH/RESUPPLY)	
	INTERVAL DAYS TOTAL SERVICES	
	TMS/OTV REQUIRED	STATION HRS PER SERVICE
	™ NOT APPLICABLE	EVA HRS PER SERVICE
		EVA CREW SIZE
3.	STATION OPERATIONAL SUPPORT (AVG. TIME FOR N	MONITOR, INSPECT, ETC.)
	8 HRS PER DAY (INTERNAL)	
	HRS PER DAY (EVA)	•
	☐ NOT APPLICABLE	•
4.	RECONFIGURATION	
	INTERVAL DAYS TOTAL RECONFIGS.	
		STATION HRS PER RECONFIG.
	☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
		EVA CREW SIZE
E	DEACTIVATION/REMOVAL	
J.	DATE(S) 1990 INT. HRS EVA H	HPS EVA CREW
	161. And EVA II	
	□ NOT APPLICABLE	
6.	NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	ABOVE)
1. 3.		<pre>sed. Crew tasks: monitoring, control/ ng, load/unload samples in furnace,</pre>

Code: GDCD 1211 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Silicon Crystals

Reference Documents:

1. Monsanto Company, User Fact Sheet

Narrative:

The data was primarily from Ref 1. The experiment proposes to produce 25 to 50 millimeter dislocation-free silicon crystal ingots with uniform homegeneous properties both with respect to dopant distributions and to micro-defect incorporation. The growth method would be floating zone possibly in a mirror furnace.

The association with accommodating payload element (GDCD 0400) was derived from association of payload objectives and requirements.

	Page 1 of 3
PAYLOAD ELEMENT NAME Heat Resistant Alloy Processing	- -
W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division	Applications (non-commercial)
Addrass P.O. Box 85357 San Diego, CA 92138	X Commercial
Telephone (619) 277-8900, Ext. 3778/2130	- Technology Development
STATUS Decrational Delanned	Operations
Approved XCandidate Opportunity	Type Number 8
First flight, yr 1997 No. of flights 1 Duration of Flight, days 30	Importance of the Space Station to
OBJECTIVE User identified objective as proprietary.	this Elosont
	could use 0 = vital
	Scale 1 - 10 8
DESCRIPTION Reference GDCD 0400 research and development facility could accommodate initial experiment, and GDCD 1205 furnace processing could accommodate pilot/commercial payload element described herein, up to 70 KW level.	ccommodate initial experiment, ercial payload element described

E J			•		
Page 2 of 3			☐ Continuous		
1 2 1 2			°3 □	Frøquency (MHZ)	/ideo
CODE 6 0 C 0 1 2 1 2	orance + + Accuracy,	Sep 'A	Aup/s	Frequen	Voice (Hrs/Day) Color Video Cther Downlink Frequency (MHZ)
	Tolerance + Ephemeris Accure	Dearth of view.	Duration, hrs/day	□ other	Uoice (Hrs/Day Uoice (Hrs/Day Other Downlink Freque
	Toler	ar DEa	U Durat		ا ا <u>ا</u> ا
	km Any		r, U	4508	NDigital U. U. Orbit) D. D.
	1800,	TION Inertial	100,000 Power.	ONS roments! Realtime Offline scryption Required Command Rate (KBS) a Processing Required	alog HBIT)
	TI:	ATION known) CU, arc	96 0 1 1 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1	6 12 13 2 E	it Malog NDIg. int) trs/Day) torage (MBIT) Frequency (Per Orbit) Rate (KBPS)
	CHARACTERIS k km Any ation, deg Angle, deg	ORIENTA action tas (If) accuracy Stabili Restrict	Operating Standby Peak	A/COMMUNICATION Litering requir None Encryption/Decipink Req.:C. Jon-Board Data Description	Typest M (Amount TO (Hrs Board Sto a Dump Fr
	Apogee, km / Inclination, Nodel Angle, Escape do Reg	POINTING/ORIENTATUION UION direction Truth Sites (If Menting accuracy Pointing Stability Special Restricti	OUER Ope St.	Monitoring requi- Monitoring requi- Mone Encryption/Di Uplink Req.: On-Board Dat: Description	Data Lice On-B Recor

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PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 1212 ELEMENT NAME	HEAT RESISTANT ALLOYS
ACCOMODATION:	E FLYER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY	Y/ATTACHMENT AND CHECKOUT)
DATE(S) 1997 INT. HRS	EVA HRS EVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICE	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3 STATION OPERATIONAL SUPPORT (AVG. TIME	FOR MONITOR, INSPECT, ETC.)
8 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
□ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECON	
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) 1997 INT. HRS	EVA HRS EVA CREW
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROU	UGH 5 ABOVE)
Monitoring, repair/replacement	O5 facility samples will be processed. Crew tasks: t, load/unload products, clean out ntrol checks. Crew tasks are not

Code: GDCD 1212

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Heat Resistant Alloy Processing

Reference Documents:

1. INCO Alloy Products User Fact Sheet

Narrative:

Objective to explore ways of using zero gravity to improve thermal and corrosion resistance properties of alloys, orbit, mass, power, data, crew size and hours and special considerations provided by Ref 1. Stated maximum power level was greater than other estimates. Although it was retained in payload excellent definition, it is believed to be high and was not used in station sizing. If such high powers do become required, the modular architectural will make it possible to satisfy user requirements. Timing, accommodation by GDCD 0400 and 1205 and other data were derived.

	Page 1 of 3
Chemical Reactions	TYPE Science &
CONTACT W. Hardy/J. Peterson MZ 21-9530 Name General Dynamics Convair Division Addrass P.O. Box 85357 San Diego, CA 92138	Applications (non-commercial) X Commercial
Telephone (619) 277-8900, Ext. 3778/2130	- Tachnology Development
STATUS Operational Planned	Operations Tupe Number
First flight, yr 1990 No. of flights 1 Duration of Flight, days 7	Importance of the Space Station to
ce of microgravity on chemical reactions.	this Eloment 1 - low value but could use 10 - vital
	Scale 1 - 10 8
DESCRIPTION GDCD 0400 research and development facility could accommodate this payload element.	s payload element.

CODE G. D. 1.2.1.3 Page 2 of 3 Tolerance + Ephemeris Accuracy, m	Earth Field of view, deg C	Duration, hrs/day Continuous	Other Frequency (MHZ)	Voice (Hrs/Day) Uoice (Hrs/Day) Other Downlink Frequency (MHZ)
Apogee, km Any Perigee, km Any Inclination, deg Any Any Escape do Required, m/s	NG/ORIENTATION Irection Inertial Solar Sites (If known) ng accuracy, arc sec ng Stability (Jitter)arc sec/se	JAC DDC Power, U Operating Standby Frequen	Caltoring requirements: Caltoring requirements: Caltoring requirements: Caltoring required Calton Required Calton Required Calton Required Calton Required Calton Required Calton Calton Required Calton Calton	Data Types! Analog Digital Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

CODE 6.0.0.1.2.1.3 Page 3 of 3	111	Remota Unpressurized H.m Stowed H.m Deployed	g min max max at Experiment ON/OFF	Hra/Fua	es, kg Man/Hrs Roq.	Returnables, kg
	THERMAL Active Passive Passive Temperature, deg C operational min Heat Rejection, w operational min Non-operational	rnal surized u,m kg rypas	CREW REQUIREMENTS 1 Task Assignment	EUA TYES XNO Reason	'-	SPECIAL CONSIDERATIONS/See Instructions Return of samples/products required.

C - 8

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GE	CO CODE_	121	3	ELEME	NT NAME	CHEMICAL	REACT	IONS	
AC	COMODAT	ION:	X ATTA	ACHED	☐ FRE	E FLYER	□ 0TV 0	OPS	
1.	STATION	ACTIVATI	ON (E.G.	SET-UP/	ASSEMBLY	//ATTACHME	NT AND C	HECKOUT)	
	DATE(S)_	1990	INT.	HRS		EVA HRS_		EVA CREW	
	-					. <u>-</u>			
	O NOT	APPLICA	BLE						
2.	SERVICE (E.G., REP	LENISH/	RESUPPL	Y)				
	INTERVA	٠	DAYS	TOTAL	. SERVICE	s			
	☐ TMS	OTV REC	WIRED_			STA	TION HRS	PER SERVICE	
	☑ NOT	af9Lica	BLE _		_	EVA	HRS PER	SERVICE	
						EVA	CREW SIZ	E.	
3.	STATION	OPERATIO	NAL SU	PPORT (A	vg. TIME	FOR MONITO	OR, INSPEC	T, ETC.)	
	0.5	_HRS PER	DAY (IR	ITERNAL)				
		_HRS PER	DAY (E	VA)					
	□ NOT	APPLICA	BLE						
4	RECONFIG	HATIO	4						
٠.				TOTA	L RECON	FIGS			
	_	OTV REQ					_	PER RECONFI	G
		APPLICA	_					RECONFIG.	
								E	
						2000		_	
5.	DEACTIVA								
	DATE(S)_	1990	INT.	HRS		EVA HRS		EVA CREW _	
	_ 	4001.404	—			<u></u>	·	-	
	וטא יַ	APPLICA	SLE						
6.	NOTES (BF	RIEFLY D	ESCRIBE	TASKS II	1 THROU	IGH 5 ABOVE	:)		
1.	This manipu	is a 7 ulate,	day m measu ackag	ission re, re e samp	. Crew cord, l les for	oad/unlo	re: mo	onitor, co oles, clea ch. Crew	an out

Code: GDCD 1213

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Chemical Reactions

Reference Documents:

1. E. I. DuPont de Nemours User Fact Sheet

Narrative:

Objective to determine influence, if any, of microgravity on chemical relations, orbit, crew involvement, and compatibility considerations provided in Ref 1. All other data including accommodation by GDCD 0400 were derived.

		Page 1 of 3
PAYLOAD ELEMENT NAME Space Isothermal Furnace (SIFS)	CODE 6 0 C 0 1 2 1 4	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division		Applications (non-commercial)
San Diego, CA 92138		X Commercial
Telephone (619) 277-8900, Ext. 3778/2130		☐ Tachnology Development
nal	× Planned	Operations
	Opportunity	Type Number 8
First flight, yr 1990 No. of flights 1 Duration of Flight, days 4 OBJECTIVE		(see Table A) Importance of the Space Station to this Element
Provide materials processing facility for commercial materials processing in space under micro gravity conditions.	for commercial materials y conditions.	1 - low value but could use 10 - vital
		Scale 1 - 10 8
DESCRIPTION The space isothermal furnace system (S	IFS) consists of multi-furr	furnace system (SIFS) consists of multi-furnace modules, each capable of
	g solid materials from 500°C to 1500°C. The system can process and 60 - 70 KW of energy. A variety of materials with differenermal process time and temperatures, and cooling rates to stable.	and 60 - 70 KW of energy. A variety of materials with different heating simal process time and temperatures, and cooling rates to stable resoliditions.
anco 0400 research and development lac	בוול כסמום מכניסיייסממנים מו	

G.D.C.D.12.14 Page 3 of 3
EQUIPMENT PHYSICAL CHARACTERISTICS Location: X Internal
sumables Types eleration sensitivity, g min max
ent Activation,
oo Tablo B) SKILL LEUEL
Hrs/Day 0.5
EUA LIYES INO Rouson Hrs/EUA
SERVICEING/MAINTENANCE SERVICEIInterval, days Returnables, kg
ANGEStInterval, day Deliverables, kg
SPECIAL CONSIDERATIONS/500 Instructions
1) P-oceas requires $22 \text{ KWh/day, process is autonomous. 2) Transient acceleration 10^{-3}g to 10^{-9}g may be acceptable depending on duration and occurrence during the processing cycle. 3) Requires$
vacuum vent access or external mounting. Furnace modules may operate in a vacuum or pressurized helium mode. 4) May be sensitive to particulate or gaseous contamination, radioactifity and RF/magnetic fields; may emit gaseous/particulate contamination and generate RF/magnetic fields.

Volume II, Book 1 Appendix I

GOCD CODE 1214	ELEMENT NAME	SPACE ISO	THERMAL	FURNACE	SYSTEM
ACCOMODATION: ATT					
1. STATION ACTIVATION (E.G DATE(S) 1990 INT					
☐ NOT APPLICABLE					
2. SERVICE (E.G., REPLENISH/	RESUPPLY)				
INTERVALDAYS	TOTAL SERVICE	s			
TMS/OTV REQUIRED.		STATI	ON HRS PER	SERVICE	
NOT APPLICABLE		EVA H	RS PER SERV	VICE _	
		EVA C	REW SIZE	_	
3. STATION OPERATIONAL SU O_5 HRS PER DAY (II HRS PER DAY (E) NOT APPLICABLE 4. RECONFIGURATION INTERVAL DAYS TMS/OTV REQUIRED	NTERNAL) VA)	FIGS			
NOT APPLICABLE			RS PER RECO		
		EVA CF	REW SIZE		
5. DEACTIVATION/REMOVAL DATE(S) 1990 INT	. HRS	EVA HRS			
NOT APPLICABLE					
6. NOTES (BRIEFLY DESCRIBE	TASKS IN 1 THROU	GH 5 ABOVE)			
 and 5. are accommods. This is a 4 day monitor, measure/ -0400 crew tasks. 	ission. Crew record. Crew	tasks are	e: Activ	/ate/ched litive to	kout,

Code: GDCD 1214

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Space Isothermal Furnace

Reference Documents:

1. GTI Corp User Fact Sheet

Narrative:

GTI has a JEA with NASA and was developing a multi-module furnace for isothermal processing of 220 separate samples at several different temperatures. Payload element objective, description, orbit, duration, size, mass, power, acceleration levels, crew size/time, and special considerations provided by Ref 1. Other data was derived such as crew skill, type and level.

Section	2.4

Discipline Industrial Services

GDCD ID NO.	PAYLOAD ELEMENT NAME
1300	Radiation Hardened Computer
1301	Full-Body Teleoperator
1302	Gamma Ray Astronomy
1303	Plants in Controlled Environment Life Support Systems (CELSS)
1304	Controlled Environment Life Support Systems (CELSS)
1305	Communication Satellite Service/Handling

		Page 1 of
<u> </u>	DE 1 2 0 0	TYPE
Radiation Hardened Computer	D C D 1	
CONTACT LIBETORY 21 0520		Applications
Nome Canara Duramice Convair Division		(NON-COMMENCIAL)
033		
San Diego, CA 92138		X Commercial
0010/0110 +23 0000 110 (013/		□ Technology
ONG (013) 2//-0300, EXC.		Development
STATUS		Ċ
Operational [Planned		Operations
Approved XCandidate Copportunity	1 ty	Tune Number
A11 - 1400		
Ė		Tangartance of the
Duration of Flight, days 1825		
E		د
Provide a radiation hardened computer.		1 - low onlum but
		•
		16 - Vital
		Scale 1 - 10 10
DESCRIPTION		

m	 			
CODE G.D.C.D.1.3.0.0 Page 2 of 3	POINTING/ORIENTATION Use direction Inertial Solar Earth Truth Sites (if known) Pointing accuracy, arc sec Pointing Stability (Jitter) arc sec/sec Special Restrictions (Avoidance)	OUER Operating Standby Peak	MUNICATIONS ng requirements! Realtime Of Uption/Decryption Requirent Requirent Requirement Requirent Requirement Requirent Requirent Requirement Requir	Data Types! Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 1000 Downlink Frequency (MHZ)

CODE 6 D C D 1 3 O O	ć	
Passive		
deg C operational m		-
PHYSICAL CHARACT		7
∵ ⊸		
	Stowed	
Laurch says, kg 0.5 H, s 0.4	Deployed	
ables Types	11	_
CREU REOUIREMENTS		_
Skills (See Table B) SKILL		11
LEUEL		_
Hrs/Day		_
EUA X VES UNO Rouson Install/Remove Hrs/FUA	4	_
		π-
	•	
Man Hours	•	
Dollvarables, kg.	7.	
Ons		п
Crew time (internal) estimate 8 hrs (4 set-up, 4 deactivate). No routine man-involvement	involvement is	

Volume II, Book 1 Appendix I

GDCD CODE 1300 ELEMENT NAME RAD	IATION HARDENED COMPUTER
ACCOMODATION: ATTACHED THE FLY	ER* OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	ACHMENT AND CHECKOUT)
DATE(S) 1990 INT. HRS 4 EVA	HRS 2 EVA CREW 1
ONOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
☑ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR N	IONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONFIGS.	
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) 1995 INT. HRS. 4 EVA H	RS _ 2 EVA CREW _ 1
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5.	ABOVE)
*Free flyer accommodation is an altern	sate mode, and if used will mooni

*Free flyer accommodation is an alternate mode, and if used will require re-evaluation of all requirements.

1. Installation and initial checkout.

3. This payload element is radiation hardened, general purpose computer developed and provided by private firm as a resource to Space Station and users. Assumed to be time shared. Man not required for normal operations peculiar to this payload element.

TOTAL	EVA	u a c	4	
LUIAL	EVA	MMA	•	

Code: GDCD 1300

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Radiation Hardened Computer.

Reference Documents:

1. Control Data Corporation, User Fact Sheet

Narrative:

Ref l letter showed intent to provide an experiment for a radiation hardened computer. Control Data also provided the economic portion of the fact sheet.

The mission date was selected consistent with the assumption that the resource would be required for the earliest Space Station application.

All the remaining data was derived.

	Page 1 of
PAYLOAD ELEMENT NAME Full-Body Teleoperator	TYPE
terson MZ 21-9530 cs Convair Division	Applications (non-commercial)
San Diego, CA 92138	X Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Tachnology Develonment
STATUS Operational Planned	Operations
_	Type Number 9
First flight, yr 1995 No. of flights 1 Duration of Flight, days 1460	Importance of the
-	loment
Provide the space station with a substantial fraction of EVA functionality without crew members leaving pressurized habitat chambers.	t could use 10 - vital
	Scale 1 - 10 10
DESCRIPTION	
Movement sensors attached to the limbs, head, and fingers of a crew member directly control A "humanoid" jointed robot outside the station. Weightlessness provides the crew member with full mobility. The robot is equipped with thrusters, controlled by the crew member for mobility. A TV camera is mounted on the "head" of the robot with control by the crew member's head movements.	a crew member directly control s provides the crew member with ed by the crew member for mo- h control by the crew member's

OF MORY OF WAR

CODE 6 D C D 1 3 O 1 Page 2 of 3	rance + Accuracy, m	DEarth of view, deg	Duration, hrs/day Continuous	Frequency (MHZ)	JHrs/Day (Hrs/Day) Other nk Frequency (MHZ)
	ORBIT CHARACTERISTICS Apogee, km Any Perigee, km Any Tole Inclination, deg Any Tolerance Nodal Angle, deg Ephemeris (ENTATION on Inertial Solar (if known) uracy,arc sec_ bility (litter)arc sec/sec_ rictions (Avoidance)	ting 500 - 1000 by Frequen	UNICATIONS g requirements! Realtime Of ption/Decryption Requir k Req.:Command Rate (Ki ard Data Processing Reciption	Data Types! Analog Digital Hi Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

CODE G.D.C.D.1.3.0.1 Page 3 of 3
X Remoted Unpre
surables Types cleration sensitivity, g min max
Task Assignme
Skills (Soo Table B) SKILL
Hrs/Day
EUA [] YES X NO Reason Hrs/EUA
SERVICING/MAINTENANCE SERVICE:Interval, days Consumables, kg
S. kg Man Hours
Deliverables, kg
_
pressurized equipment occupying less than 2 meters length packaged for delivery in Shuttle car- go bay. 2) An optical window may be required. 3) May generate particulate and gaseous contami-
nation and RF/magnetic fields; may be sensitive to RF/magnetic fields. 4) Robot and teleoperator
environment. 5) Operated by 1-man (skill/level=5/3). Crew hours for operation are accounted for
under payload using this equipment.

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Appendix I

GUC	D CODE 1301 ELEMENT NAM	E FULL-BODY TELEOPERATOR	
ACC	OMODATION: 🖸 ATTACHED 🔲 FR	REE FLYER	
1. S	TATION ACTIVATION (E.G., SET-UP/ASSEMBI	LY/ATTACHMENT AND CHECKOUT)	
0	ATE(S) 1995 INT. HRS 24	EVA HRS EVA CREW	
	□ NOT APPLICABLE		
2. S	ERVICE (E.G., REPLENISH/RESUPPLY)		
H	NTERVAL DAYS TOTAL SERVICE		:
	TMS/OTV REQUIRED	STATION HRS PER SERVICE	
	NOT APPLICABLE	EVA HRS PER SERVICE	
	•	EVA CREW SIZE	
3. S	STATION OPERATIONAL SUPPORT (AVG. TIM	E FOR MONITOR, INSPECT, ETC.)	
	HRS PER DAY (INTERNAL)		
	HRS PER DAY (EVA)		
	■ NOT APPLICABLE		
4. R	IECONFIGURATION .		
	NTERVAL DAYS TOTAL RECO	NFIGS.	
		NFIGSSTATION HRS PER RECONFIG	
	NTERVAL DAYS TOTAL RECO		
	NTERVAL DAYS TOTAL RECO	STATION HRS PER RECONFIG.	
II	NTERVAL DAYS TOTAL RECO	STATION HRS PER RECONFIG	
5. 0	NTERVAL DAYS TOTAL RECO TMS/OTV REQUIRED NOT APPLICABLE DEACTIVATION/REMOVAL	STATION HRS PER RECONFIG	
5. 0	NTERVAL DAYS TOTAL RECO TMS/OTV REQUIRED NOT APPLICABLE DEACTIVATION/REMOVAL	STATION HRS PER RECONFIG. EVA HRS PER RECONFIG. EVA CREW SIZE	
5. 0	NTERVAL DAYS TOTAL RECO TMS/OTV REQUIRED NOT APPLICABLE DEACTIVATION/REMOVAL	STATION HRS PER RECONFIG. EVA HRS PER RECONFIG. EVA CREW SIZE	
5. 0	NTERVAL DAYS TOTAL RECO ☐ TMS/OTV REQUIRED ☑ NOT APPLICABLE DEACTIVATION/REMOVAL DATE(S) 1999 INT. HRS. 24	STATION HRS PER RECONFIG. EVA HRS PER RECONFIG. EVA CREW SIZE . EVA HRS EVA CREW	
5. 0 0	NTERVAL DAYS TOTAL RECO TMS/OTV REQUIRED NOT APPLICABLE DEACTIVATION/REMOVAL DATE(S) 1999 INT. HRS. 24 NOT APPLICABLE HOTES (BRIEFLY DESCRIBE TASKS IN 1 THRO	STATION HRS PER RECONFIG. EVA HRS PER RECONFIG. EVA CREW SIZE EVA HRS EVA CREW DUGH 5 ABOVE)	
5. 0 0	NTERVAL DAYS TOTAL RECO TMS/OTV REQUIRED NOT APPLICABLE DEACTIVATION/REMOVAL DATE(S) 1999 INT. HRS. 24 NOT APPLICABLE HOTES (BRIEFLY DESCRIBE TASKS IN 1 THRO Initial checkout This payload element provides	STATION HRS PER RECONFIG. EVA HRS PER RECONFIG. EVA CREW SIZE EVA CREW DUGH 5 ABOVE) S a portion of the Space Station EVA	₹ rea
5. 0 0	NTERVAL DAYS TOTAL RECO TMS/OTV REQUIRED NOT APPLICABLE NOT APPLICABLE NOT APPLICABLE NOTES (BRIEFLY DESCRIBE TASKS IN 1 THRO Initial checkout This payload element provides function. A specially traine controls the operation of a second control of the control of	STATION HRS PER RECONFIG. EVA HRS PER RECONFIG. EVA CREW SIZE EVA CREW OUGH 5 ABOVE) S a portion of the Space Station EV/ed crew member in the pressurized at robot outside the station. The EVA	rea
5. 0 0	NTERVAL DAYS TOTAL RECO ☐ TMS/OTV REQUIRED ☑ NOT APPLICABLE DEACTIVATION/REMOVAL DATE(S) 1999 INT. HRS. 24 ☐ NOT APPLICABLE HOTES (BRIEFLY DESCRIBE TASKS IN 1 THRO Initial checkout This payload element provides function. A specially traine controls the operation of a function as described could be periodically after it becomes	STATION HRS PER RECONFIG. EVA HRS PER RECONFIG. EVA CREW SIZE EVA CREW EVA CREW DUGH 5 ABOVE) S a portion of the Space Station EV/ ed crew member in the pressurized and robot outside the station. The EVA crew be used by many payload elements available (est. 1995). Crew hours	rea
5. 0 0	NTERVAL DAYS TOTAL RECO ☐ TMS/OTV REQUIRED ☑ NOT APPLICABLE DEACTIVATION/REMOVAL DATE(S) 1999 INT. HRS. 24 ☐ NOT APPLICABLE HOTES (BRIEFLY DESCRIBE TASKS IN 1 THRO Initial checkout This payload element provides function. A specially traine controls the operation of a prinction as described could be periodically after it becomes for operation are accounted to	STATION HRS PER RECONFIG. EVA HRS PER RECONFIG. EVA CREW SIZE EVA CREW SIZE OUGH 5 ABOVE) S a portion of the Space Station EV/ed crew member in the pressurized at robot outside the station. The EVA be used by many payload elements	rea

TOTAL EVA HRS 0

Code: GDCD 1301

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Full-Body Teleoperator

Reference Documents:

1. Glob Enterprises, Space Products Division, User Fact Sheet

Narrative:

Ref 1 provides the data for this payload element, including special considerations. The date was selected consistent with the user desires. The full-bodied teleoperator would provide the Space Station with a substantial fraction of EVA functions without crew members leaving the pressurized volume. Movement systems attached to IVA crewman limbs, head, fingers directly control a jointed robot outside.

The LXWXH measurements were derived by taking the cube root of Ref 1 pressurized volume. Cres skill/level and time were derived.

	Page 1 of 3
PAYLOAD ELEMENT NAME GOOF G. D. C. D. 1.3.0.2	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division	Applications (non-commercial)
San Diego, CA 92138	X Commercial
Telephone (619) 277-8900, Ext. 3778/2130	☐ Tachnology Development
STATUS	Operations
	Type Number 9
ght, yr 1990 Ights 1 of Flight, days 60	Importance of the Space Station to
	this Element
Gamma ray spectroscopic studies of high energy astrophysical sites.	1 - low value but could use 10 - vital
	Scale 1 - 10 5
DESCRIPTION	
GDCD 0030 gamma ray observatory probably could accommodate this payload element which has been identified by a commercial institution.	oayload element which has been

CODE 6.0,C,01,30,2 Page 2 of 3	ORBIT CHARACTERISTICS Apogeo, km 400 Tolerance + 50 = 50 Inclination, deg 0 Tolerance + 28.5 = 0 Nodal Angle, deg Ephemeris Accuracy, m	ENTAT	- 13 23	☐Ac ☐DC Power, ☑ Duration, hrs/day	Peak Poltage, U Frequency, Hz	UNICATIONS g requirements! XRealtime 00f	Encryption/Decryption Required Uplink Req.: Command Rate (KBS) On-Board Data Processing Required Description	Types: XAnalog XDigital CAmount)	Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) Damilink Frequency (MHZ)
-----------------------------------	---	-------	---------	------------------------------------	-------------------------------	--	--	----------------------------------	--

	·	ORIGINA OF POO	IL P R Q	age T	₫ ' Y		Appendix I
CODE 6 D C D 1 3 0 2	Lain max	ed 3 Stowed 3000 Deployed	Xam un R / Box Aragon	o Table B) SKILL	Hrs/Day	SERVICING/MAINTENANCE SERVICE: Interval, days Consumables, kg Returnables, kg Returnables, kg Deliverables, kg Returnables, kg	.lons as low as possible with near equatoria below charged particle belts. 2) Down d radioactive contamination; sensitive Prefers isolation from nearby equipme

Volume II, Book 1 Appendix I

GDCD CODE 1302	ELEME	NT NAMEGAMM/	A RAY ASTR	RONOMY	
ACCOMODATION:	ATTACHED	X FREE FLYER	□ 0TV 0	PS	
1. STATION ACTIVATI	ION (E.G., SET-UP/	ASSEMBLY/ATTACH	IMENT AND CH	IECKOUT)	
DATE(S) 1990	INT. HRS	EVA HR	S	EVA CREW	
			-		
NOT APPLICA	RFF				
2. SERVICE (E.G., RIP	LENISH/RESUPPL	Y)			
INTERVAL	DAYS TOTAL	L SERVICES			
THE/OTY REC	QUIRED		TATION HRS F	PER SERVICE	
NOT APPLICA	BLE		VA HRS PER S	SERVICE	
		(EVA CREW SIZI	E	
3. STATION OPERATIO	ONAL SUPPORT (A	VG. TIME FOR MON	IITOR, INSPECT	T, ETC.)	
HRS PE	R DAY (INTERNAL	.)			
HRS PER					
■ NOT APPLICA					
4. RECONFIGURATION	a u				
INTERVAL		AI RECONEIGS			
☐ TMS/OTV RED				ER RECONFIG.	
				ECONFIG	
X NOT APPLICA	DLE	_	VA CREW SIZE		
		•	AW CUEM 2175		
5. DEACTIVATION/RE	MOVAL				
DATE(S)	INT. HRS	EVA HRS		EVA CREW	<u></u>
-					
NOT APPLICA	8LE				
6. NOTES (BRIEFLY D	ESCRIBE TASKS I	N 1 THROUGH 5 ABO	OVE)		
This payload is in basic researd			s of com	mercial users	interested
Accommodatio	on is based	on capability	of GRO (GDCD-0030)	
. Deactivation	م المالية		ماسماليراسم	, 	

TOTAL EVA HRS _____0

Code: GDCD 1302

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Gamma-Ray Astromony

Reference Documents:

1. Bell Labs, User Fact Sheet

Narrative:

Free-flyer accommodation is assumed based on compatibility with Gamma-Ray Observatory GDCD 0030.

The launch date was derived based on the assumption that the experiment equipment would be available at the earliest opportunity since balloon flights are currently being made.

The height dimension is an estimate.

This payload element is assumed to be representative of a class of commercial users who desire to conduct basic research in space.

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CODE
Science 1
X Commercial
Technology
Tendo lo part
Operations
•
Type Number 9
(see Table A)
Importance of the
this Element
1 - low value but could use
10 - vital
Scale 1 - 10 10
1990) would involve: 1) test equipment and procedures for monitoring gas in algae and plant growth chambers, 2) determine the characteristics of
algae culture growth in the low gravity and high energy radiation condition space, 3) test algae native models for CELSS. GDC 0341 CELSS could accommodate this payload element. The
te e e e e e e e e e e e e e e e e e e

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CODE 6. D. C. D 1, 3, 0, 3, Page 2 of	ຕຼ
km Any Periges, km Any Tolerance + ition, deg Any Tolerance + ingle, deg Ephemeris Accuracy, m	
POINTING/ORIENTATION Use direction Inertial Solar Earth Truth Sites (if known) Pointing accuracy, arc sec Field of view, deg Pointing Stability (Jitter) arc sec/sec Special Restrictions (Avoidance)	
POUER Operating Standby Pock Voltage, V	of foot game
UNICATIONS graduirements; [Realtime Of ption/Decryption Requir k Req.: Command Rate (Ki ard Data Processing Req iption	
OAnalog Objette By (MBIT) uency (Per Orbit)	
rding Rat	

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m		0F POOK	· 2 · · · ·				
Page 3 of		Stowed Deployed	l Real Time , Maintenance			.	IONS/Soo Instructions to filtered sunlight. 2) May require constant rotation for artificial artificial artificial gravity levels. 3) Storage of H2O, O2, CO2, N2 and experiment ensitive to particulate and gaseous contamination, radioactivity and RFI emit gaseous and particulate contamination.
CODE 6.0,0,1,3,0,3	X X X X X X X X X X X X X X X X X X X	po z	rogrammaged riment Contr		Hrs/EUA		PECIAL CONSIDERATIONS/See Instructions 1) May require access to filtered sunlight. 2) May require constant rotation for artificial gravity or a range of artificial gravity levels. 3) Storage of H ₂ O, O ₂ , CO ₂ , N ₂ and experimen supplies. 4) May be sensitive to particulate and gaseous contamination, radioactivity and RFI magnetic fields; may emit gaseous and particulate contamination.
	# T T T T T T T T T T T T T T T T T T T	nal Remote urized Unpressurized U,m H,m H,m kg ypes	4	2 2	1 7.0	Consumables, Man Hours	10N5/5ee Instructions to filtered sunlight. 2) May require constartificial gravity levels. 3) Storage of Pensitive to particulate and gaseous contamiemit gaseous and particulate contamination.
·	ational ational ational	CHARACTERISTICS nal External on Pressurized L,m J,m L,m J,m C,m U,m Caunch mass, kg Consumables Types	Task		Reason	yab ,	red sunlight. 2) M al gravity levels. to particulate and ous and particulate and
	eg C non-	PHYSICAL CHARAC Internal ID/Function L,m L,m L,m Consum	1 1	rable B)	№	1 nx-	IDERATIONS/Soc access to filtered ange of artificial by be sensitive to s; may emit gaseous
	THERMAL 	EQUIPMENT PHY Location! Equipment ID.	CREU REQUIREMENTS	Skills (See Table	EUA 🗌 YES	SERVICING/MAINTENANCE SERVICE:Interval, day Returnables, CONFIGURATION CHANGES	SPECIAL CONSIDERAT 1) May require access gravity or a range of supplies. 4) May be se magnetic fields; may e

Volume II, Book 1 Appendix I

GOCD CODE 1303 ELEMENT NAME	PLANTS IN CELSS
ACCOMODATION: X ATTACHED - FRE	
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBL	Y/ATTACHMENT AND CHECKOUT)
DATE(S) 1990 INT. HRS	EVA HRS EVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICE	ES
TMS/OTV REQUIRED	STATION HRS PER SERVICE
🗵 NOT APPLICABLE 👱	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME	FOR MONITOR, INSPECT, ETC.)
0.2 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
☐ NOT APPLICABLE	•
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECOM	NFIGS
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
S. DEACTIVATION/REMOVAL	
DATE(SI 990 INT. HRS.	EVA HRS EVA CREW
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THRO	UGH 5 ABOVE)
1. Activation assumed as part of	station OPS
3. Accommodated by GDCD-0341. Ac	ided crew time charged to this
payload element for peculiar a 5. Deactivation part of station (activities only. DPS

Code: GDCD 1303

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Plants in Controlled Environment Life Support Systems

(CELSS)

Reference Documents:

1. Texas A&M University, User Fact Sheet

Narrative:

The Ref 1 fact sheet data described two payload elements. The first develops a facility for supporting algal and plant life. The second (GDCD 1304) uses the facility in constructing commercial CELSS. Power and weight provided in the fact sheet primarily applies to the commercial facility.

The 1990 date is extrapolated from fact sheet based similar use in the Space Stations during the same period.

The Ref to GDCD 0341 accommodation is derived by similarity of objectives/descriptions.

Crew related data is derived.

All other data is from Ref 1.

Page 1 of and RF/magnetic fields. CELSS may emit gaseous and particular contamination. 4) Accommodation of CELSS should consider need for temperature and light control. 5) GDCD 0342 dedicated cells DESCRIPTION 1) Reference GDCD 1303 for development of this payload element. 2) Weight, vol-3) Operational CELSS may be sensitive to particular and gaseous contamination, radioactivity ume and power estimates for this payload element are defined for each crew member supported. (non-commercial) σ さかの 1 - low value but Applications Dovolopment Importance of Space Station could usa Technology Operations this Eloment Scale 1 - 10 X Commercia! Type Number (see Table Science 10 - vital TYPE Provide space station controlled environment life support sys-0 က ں ☐ Planned ※ Candidate ☐ Opportunity module, could accommodate this payload element. General Dynamics Convair Division tem (CELSS) based on plant experiments. >180 W. Hardy/J. Peterson MZ 21-9530 (619) 277-8900, Ext. 3778/2130 days San Diego, CA 92138 Controlled Environment LSS PAYLOAD ELEMENT NAME P.O. Box 85357 Flight Operational Opproved No. of flights First flight, Duration of Telephone OBJECTIVE Addross CONTACT STATUS OEON

OR	IGINAL	PAUL	
OF	POOR	OUALI	TY

C	OF POOR QUALITY				
Page 2 of			□ Continuous	, (MHZ)	НZ)
CODE 6 D C D 1 3 O 4	Apogee, km Any Perigee, km Any Tolerance + Inclination, deg Any Tolerance + Ephemeris Accuracy, m Escape dV Required.m/s	OINTING/ORIENTA low direction ruth Sites (if ointing accurac ointing Stabili		MMUNICATIONS Ing requirements! Realtime Of Realtime Of Ryption/Decryption Requision Requision Requision Reference (King See Command Reference (King Recent Decryption) In Purpose Computer	Data Types: Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

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	M		
CODE G D C D 1 3 0 4		ad 2.1 Stowed Deployed	Preprogrammed and Real Time Control; Maintenance Hrs/EUA Rg Returnables, kg
	THERMAL ———————————————————————————————————		Assignment 2 2 2 2 2 Ann Hours Kg Consumables, Kg ons rotation without ov specimens are TBD.

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GDCD CODE 1304 E	LEMENT NAME	CELSS		
ACCOMODATION: 🔯 ATTACH				
1. STATION ACTIVATION (E.G., SE	T-UP/ASSEMBLY/A	ATTACHMEN	T AND CHECKOUT)	
DATE(S) 1996 INT. HR	SE	VA HRS	EVA CREW	
				
NOT APPLICABLE				
2. SERVICE (E.G., REPLENISH/RES	UPPLY)			
INTERVAL DAYS T	OTAL SERVICES			
TMS/OTV REQUIRED		STAT	ION HRS PER SERVICE	
■ NOT APPLICABLE		EVA	RS PER SERVICE	
		EVA	REW SIZE	
3. STATION OPERATIONAL SUPPO	RT (AVG. TIME FO	OR MONITO	R, INSPECT, ETC.)	
0.2 HRS PER DAY (INTE	RNAL)			
HRS PER DAY (EVA)				
☐ NOT APPLICABLE				
4. RECONFIGURATION				
INTERVAL DAYS	TOTAL RECONFIC	GS		
TMS/OTV REQUIRED		STATI	ON HRS PER RECONFI	G
☑ NOT APPLICABLE		EVA H	RS PER RECONFIG.	
		EVA C	REW SIZE	
5. DEACTIVATION/REMOVAL				
DATE(S)1996 INT. HR	s E\	/A HRS	EVA CREW	
			•	
☐ NOT APPLICABLE				
6. NOTES (BRIEFLY DESCRIBE TAS	SKS IN 1 THROUG	H 5 ABOVE)		
. Activation part of s		c navlos	d alamant char	and only

Accommodated by GDCD-034. This payload element charged only for additional crew time for peculiar objectives.
 Deactivation part of station OPS

			0	
TOTAL	EVA	HRS		

Code: GDCD 1304

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Controlled Environment Life Support System (CELSS)

Reference Documents:

1. Texas A&M University, User Fact Sheet

Narrative:

The Ref 1 fact sheet data described two payload elements. The first develops a facility for supporting algal and plant life (Ref GDCD 1303). The second payload element uses the facility in constructing commercial CELSS. LXWXH data is derived from this cube root of the pressurized volume and applies to each crew member. The reference to GDCD 0342 accommodation is derived from similarity of objective/descriptions.

All other data is from Ref 1.

	Page 1 of 3
Communications Satellite Service/Handling 6 0 c 0 1 3 0 5	TYPE
W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division	Applications (non-commercial)
Hddross P.O. Box 85357 San Diego, CA 92138	X Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Technology
- Approved Candidate	Operations
First flight, yr 1992 No. of flights Duration of Flight, days 30	Table A)
4	this Element
Provide service to increase life and enhance system operations for larger, more complex commercial communications satellites (1500 to 2500 Kg).	1 - low value but could use 10 - vital
	Scale 1 - 10 10
DESCRIPTION	
Prelaunch activities for assembly, deployment and testing of large antennas. Refuel of liquid propulsion system. Replace and/or reconfigure communications payload elements. Test new subsystems. Deploy and handle satellite (Ref. GDCD 2504 &2505 for on-orbit for communication service & handling of satellite). New technology experimental/development for communication satellites is also identified by the user (Ref. GDCD 1106 for antenna development).	ge antennas. Refuel of liquid load elements. Test new sub-n-orbit for communication evelopment for communication tenna development).

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G D C D 1 3 0 5 Page 3 of		H, m Stowed Stowed H, m Deployed Satellite Propellants	Hrs/EUA Hrs/EUA Hrs/EUA Hrs/EUA Hrs/EUA Man/Hrs F Returnab Spacecraft (e.g., p uired during comm P/ s with pointing accu	
	THERMAL ———————————————————————————————————	Lzed⊠Unpre.	CREU REQUIREMENTS Crew Size Skills (See Table B) EUA [SKILL Hrs/Day EUA [] YES	stability up to 20 arc/sec and power up to 500 watts.

Volume II, Book 1 Appendix I

GDCD CODE 1305 ELEMENT NAME COMM	IOM. SAT SERVICE/HANDLING			
ACCOMODATION: X ATTACHED TREE FLY	ER OTV OPS			
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)				
DATE(S) 1992 INT. HRS EVA	HRS EVA CREW			
NOT APPLICABLE				
2. SERVICE (E.G., REPLENISH/RESUPPLY)				
INTERVAL DAYS TOTAL SERVICES				
TMS/OTV REQUIRED	STATION HRS PER SERVICE			
NOT APPLICABLE	EVA HRS PER SERVICE			
	EVA CREW SIZE			
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR A	AONITOR, INSPECT, ETC.)			
HRS PER DAY (INTERNAL)				
HRS PER DAY (EVA)				
☐ NOT APPLICABLE				
4. RECONFIGURATION				
INTERVAL DAYS TOTAL RECONFIGS.				
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.			
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.			
	EVA CREW SIZE			
5. DEACTIVATION/REMOVAL				
DATE(S) 1992 INT. HRS EVA	IRS EVA CREW			
NOT APPLICABLE				
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	ABOVE)			
1, 3 and 5. Accommodation requirement GDCD-2504, 2505 and 1106.	nts accounted for under			

Page 1 of 1 Volume II, Book 1 Appendix I

Code: GDCD 1305 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Communications Satellite Servicing and Handling

Reference Documents:

1. RCA Astro-Electronics, User Fact Sheet

Narrative:

Ref 1 describes two types of user activities.

- a. Handling of large communication satellites on orbit
- b. New technology experimentation/development for communications satellites.

GDCD 2504 OTV Payload Handling and GDCD 2505 Payload Servicing and Repair can accommodate handling requirements of this payload element, while GDCD 1106 Large Deployable Antenna accommodates antenna development objectives.

Mission data and crew related data for this payload element was derived.

TECHNOLOGY DEVELOPMENT MISSIONS

Section	3.1	

Discipline Materials & Structures

GDCD ID NO.	PAYLOAD ELEMENT NAME
2001	Strain and Acoustic Sensors
2002	Spacecraft Materials Technology
2003	Materials and Coatings
2004	Thermal Shape Control
2005	Dynamics of Flimsy Structures
2006	Active Optics Technology
2007	Large Structures Technology

		Page 1 of 3
PAYLOAD ELEMENT NAME Strain and Acoustic Sensors	CODE G D C D 2 O 0 1	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Name General Dynamics Convair Division		Applications (non-commercial)
nuarass P.O. Box 85357 San Diego, CA 92138		Cormercial
Telephone (619) 277-8900, Ext. 3778/2130		X Tachnology Development
nal	ned ned	Operations
☐ Approved ☐ ☐ Opportuni	Candidate Opportunity	Type Number
First flight, yr 1990 No. of flights 1 Duration of Flight, days 3650+		(see Table A) Importance of the Space Station to this Element
Develop technology necessary to examine spacecraft structures and provide long-term structural verification through advanced nondestructive evaluation. Test such systems on early spacecramissions and improve to meet monitoring needs.	cecraft structures 1 on through advanced s on early spacecraft 10.	1 - low value but could use 10 - vital
		Scale 1 - 10 5
Advanced acoustic emission sensors designed monitored during the mission by a preprograntested and will take advantage of our curressensors. Additional sensors designed to monferometric sensors which have been developed	and built into the sp mmed computer. The sen nt R&D program output itor strain with acous d at LaRC will be stru	emission sensors designed and built into the spacecraft structure will be he mission by a preprogrammed computer. The sensors will be developed and ke advantage of our current R&D program output to provide state-of-the-art sensors designed to monitor strain with acoustics and fiber-optic interwhich have been developed at LaRC will be structurally integrated as well.

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CODE 6 0 0 0 0 1 Page 2 of	(7)
rics Periges, km LEO Tolerance +	
Tolerance +	
J, m/s	
POINTING/ORIENTATION Usew direction	
ruth Sites (If known)	1
Stability (Jitter)arc sec/sec	
OUER NAC	
Monitoring requirements: Offline Other	
Iption Required	
On-Board Data Processing Required	T
Description Monitor Acoustics	
11 Analog Digite	
olca	71
torage (MBIT)	
Data Dump Frequency (Per Orbit) Decording Data (VDBs) 1.0 Decording Data (VDBs)	_
RATE (KDF3/	T

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CODE 6.0.2.0.0.1 Page 3 of 3	۳. -
1 1 1 1	
Equipment ID/Function Pressurized Unpressurized Equipment ID/Function Pressurized Unpressurized L,m	7
Task Assignment Monitor Sen	
Skills (See Table B) SKILL 1	
EUA X VES NO Remann Sensor Replacement Heavella 120	
JICING/MAINTENANCE JICE Interval, days Returnables, kg Returnables, kg Ann Hours	।
CONTIGURATION CHANGESTINGSTORI, day Deliverables, kg Returnables, kg	П
Space Station provides necessary long term exposure to the space environment as well as access for specimen removal, replacement, and insitu testing. At some point this would cease to be an experiment and would be incorporated as part of the station. Reconfiguration is inherent in servicing.	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GOCD CODE_	2001	ELEME	NT NAME	STRAIN	AND	ACOUS	TIC S	SENSORS
ACCOMODATI	ON:	ATTACHED	☐ FRE	E FLYER	- 01	rv ops		
1. STATION A	CTIVATION	(E.G., SET-UP)	ASSEMBLY	/ATTACHME	ENT AN	D CHEC	KOUT)	
DATE(S) 1	990	INT. HRS		EVA HRS_		E	VA CRE	EW
_								
□ NOT	APPLICABLE	1						
2. SERVICE (E	E.G., REPLEN	IISH/RESUPPL	.Y)					
INTERVAL	180 DA	YS TOTA	L SERVICE	s <u>20</u>	_			
☐ TMS/	OTV REQUIR	RED		STA	TION H	RS PER	SERVI	CE
□ NOT	APPLICABLE			EV	A HRS P	ER SER	VICE	6
				EV	A CREW	SIZE		1
O NOT	HRS PER DA HRS PER DA APPLICABLE URATION OA OTV REQUIF APPLICABLE	AY (INTERNA) E YS TOT	L)	FIGS STA EVA	TION H	RS PER ER REC	RECON	IFIG
. – .				EVA HPS		EV	A CREV	v
DA 15(3)		ini. mna		EVA nns			- CIILI	·
— ⊠ NOT	APPLICABLE							
6. NOTES (BR	HEFLY DESC	RIBE TASKS	IN 1 THROL	IGH 5 ABOV	E)			
1. Origi 2. Repla 3. Opera 4. Recon 5. Senso	nal plac cement/i tional a figurati rs not r	ement of nspection ssurance on inhere	sensors of sen monitor ent in s	part of sors 1 o ing ervicing	stat lay ev	ery (5 mos	

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2001

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Strain and Acoustic Sensors

Reference Documents:

 Technology Development Missions, Space Station NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982, attachment A, p 41

Narrative:

The payload element objective, description, EVA reasons, and special considerations are based on Ref 1.

All other data is derived.

Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2001

PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Space Structures Technology

Langley Contact: Joseph Heyman

Development

MS 499/ X3418

Experiment Title: Spacecraft Strain & Acoustic Emission Sensors

Mission Objectives: Develop technology necessary to examine spacecraft structures

and provide long-term structural verification through

advanced Nondestructive Evaluation (NDE). Test such systems on early spacecraft missions and improve to meet monitoring

needs.

Mission Description: Advanced acoustic emission sensors designed and built into the spacecraft structure will be monitored during the mission

by a preprogramed computer. The sensors will be developed and tested on the ground and will take advantage of our

current R&D program output to provide state-of-the-art sensors. Additional sensors designed to monitor strain with acoustics and fiber-optic interferometric sensors which have been

developed at LaRC will be structurally integrated as well.

Benefit:

The life of the Spacestation may very well depend on integrated

NDE with the structural design and Quantitatively monitoring

material/structural properties during long-term space

environment exposure (environment plus control). Proper monitoring may both identify problems before they become critical as well

as prevent problems caused by improper control technology.

Justification:

Need for real spacestation environment and long duration

tests to evaluate methodology.

Mission Requirements and Capability: Spacestation

Space Station vs. Free Flyer:

	Page 1 of 3
PAYLOAD ELEMENT NAME Spacecraft Materials Technology G D C D 2 0 0 2	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Name General Dynamics Convair Division	Applications (non-commercial)
San Diego, CA 92138	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	X Technology Development
nal	□ Operations
First flight, yr 1991 No. of flights 1 Duration of Flight, days 3300+	(see Table A) Importance of the Space Station to
	this Element
To provide a technology data base for long term use of advanced materials in space.	1 - low value but could use 10 - vital
	Scale 1 - 10 6
DESCRIPTION The proposed mission would provide a unique opportunity to develop a long term space enviornmental durability data base on advanced thermal control coatings, adhesives, composites, and polymer films. Specific experiments would be developed to evaluate the effects of each exposure parameter, both singly and combined, on the properties of these materials. Insitu evaluation of properties could be performed.	op a long term space enviorn- , adhesives, composites, and te the effects of each ex- these materials. Insitu

ORIGINAL PAGE IS OF POOR QUALITY

G D C D 2 0 0 2 Page 2 of 3		DEarth of view, deg	ion, hrs/day	ther Frequency (MHZ)	Uhra/Day (Hrs/Day) Other Ink Frequency (MHZ)
	# Ann	On Inertial Osolar OEarth Inoun) arc sec Field of view, (Jitter)arc sec/sec	. U Duration, hrs/day Frequency, Hz	JNICATIONS Jrequirements! Realtime Offline Other Stion/Decryption Required Req.: Command Rate (KBS) Ind Data Processing Required	Data Types: Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

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CODE 6.0 C.0 2 0 0 2	Page 3
THERMAL Greative Passive Temperature, deg C operational min max non-operational min max Heat Rejection, w operational min max non-operational min max	
S Remote Ized Unpressurized	Stowad
sumables Types	De No Lad
Task Assignment Monitor and	Specimens
se Table B) SKILL LEVEL	
0 ha	
EUA X VES	100
Consumables	•
Interval, day Man/Hrs Roq.	
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Space Station required to provide access for specimen removal, replacement, and periodic insitu	periodic insitu
testing. Low power essential, level undetermined. Reconfiguration is inherent in servicing.	servicing.

GDC-ASP-83-002

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix !

GDCD CODE 2002 ELEMENT NAME	SPACECRAFT MATERIALS TECHNOLOGY
ACCOMODATION: 🖸 ATTACHED 🗆 FR	EE FLYER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBL	Y/ATTACHMENT AND CHECKOUT)
DATE(S) 1991 INT. HRS	EVA HRSEVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 180 DAYS TOTAL SERVIC	ES
TMS/OTV REQUIRED	STATION HRS PER SERVICE
□ NOT APPLICABLE	EVA HRS PER SERVICE 5
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME	E FOR MONITOR, INSPECT, ETC.)
0.1 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
☐ NOT APPLICABLE	·
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECOR	VFIGS
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
■ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) INT. HRS	EVA HRSEVA CREW
M NOT APPLICABLE	

- 6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)
- Experimentation starts in 1991. Setup time station OPS
 5 hours 2 times a year are allocated for sample placement/retrieval
 Operational support for examination and measurement
- 4. Reconfiguration inherent in servicing.
- 5. Experimentation runs past year 2000.

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2002

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Spacecraft Materials Technology

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation meeting NASA Hq., 14-15 Sept 1982

Narrative:

Payload element objective, description, EVA reasons and special considerations are based on Ref 1.

All other data is derived.

Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2002

PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title:

Langley Contact:

Spacecraft Materials Technology

D. R. Tenney, W. S. Slemp,

G. F. Sykes

Experiment Title:

Mission Objectives:

To provide a technology data base for long term use of advanced materials in space

Mission Description:

The proposed mission would provide a unique opportunity to develop a long term space environmental durability data base on advanced thermal control coatings, adhesives, composites, and polymer films. Specific experiments would be developed to evaluate the effects of each exposure parameter, both singly and combined, on the properties of these materials. Insitu evaluation of properties could be performed.

Benefit:

Long term exposure data is not available, therefore a data base would be generated that would provide a basis for more efficient space structure design. The generated data would provide verification for ongoing materials exposure programs in ground-based facilities.

Justification:

Long term laboratory simulation experiments are expensive and limited because a complete space environment consisting of extreme ultraviolet, vacuum, atomic oxygen and thermal cycling cannot be duplicated in the Earth-b sed laboratories.

Mission Requirements and Capability:

Space station is required to provide access for specimen removal, replacement and periodic insitu testing. Power (level TBD) would be essential. Orbit requirements designed to provide maximum environmental expsoure.

Space Station vs. Free Flyer:

ORIGINAL PACE OF POOR QUALITY

n Page 1 of vestigation include the degradation of the reflectivity of mirror/antenna metallic coatings as well as the decrease in the absorptivity of low-scatter optical black surfaces when exposed to solar illumination and solar wind/cosmic ray high energy particle fluxes. Meteoroid venting of DESCRIPTION Data will be obtained on the effect of the space environment on critical phyresin-matrix structural composite materials due to cosmic ray damage and vacuum effects; and the interstitial spaces of thermal insulating materials; decreases in the Young's Modulus of sical properties of materials and coatings for use in space projects. Specific areas of inparticle contamination of the thermal-control coatings applied to heat pipes are also tech-10 ω (NON-COMMERCIAL) 1 - low value but Applications Development (See Table A) Importance of Space Station could use X Tachnology Opporations this Element - 10 Commercia Type Number Science . vital Scale 1 TYPE absorbing surface coatings capable of sustained performance in **OBJECTIVE** To provide a technology base for the production of structural and insulating materials, and optical, thermal, and C 0 0 Opportunity CODE ☐ Planned

※ Candidate
☐ Opportunit General Dynamics Convair Division 3300+ M. Hardy/J. Peterson MZ 21-9530 (619) 277-8900, Ext. 3778/2130 Shep San Diego, CA 92138 P.O. Box 85357 PAYLOAD ELEMENT NAME No. of flights I Materials and Coatings the space environment. □ Operational □Approved First flight, yr nological concerns. Telephona Addross CONTACT STATUS Nemo

ORIGINAL PAGE IS OF POOR QUALITY

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GD CD 2 0 0 3 Pege 2 of	4 1	F × > + -	<u>:</u>	MMUNICATIONS ing requirements: Realtime Of Realtime Of ryption/Decryption Requirement Requirement Requirement Reterment Re	Data Types! Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

ORIGINAL PAGE 19 OF POOR QUALITY

	G D C D 2 0 0 3 Page 3 of 3
TICS Remote saurized Vupre	×
itivity.	Deptoyed mex
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s (See Table B) SKILL IEUEL	
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EUA X YES UND Reason Inspection/Service	Hrs/EUA 100
IANCE 180	ľ
os, kg NGESiInterval, dau	Man/Hrs Rog.
Dellverab	
, a	Orbit inclination and altitude will be
large dimensions anticipated for the surface coatings used in future space projects, the area	ture space projects, the area
of the samples investigated in the proposed mission must be on the order of many square meters. Since optical spectrometers of high positional sensitivity will be utilized in the reflectivity	he order of many square meters.
and absorptivity measurements, a high degree of stability will be required of the Space Station	e required of the Space Station.
service is for sample retrieval. Recomminduration is innerent in servicing.	servicing.

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Bool∙ 1 Appendix I

GE	OCD CODE_	2003	ELEN	IENT NAME	<u>MATERIA</u>	LS AND (COATINGS	
AC	COMODATI	ON: 🗵	ATTACHED	FRE	EFLYER	OTV OF	PS	
1.	STATION A	CTIVATION	(E.G., SET-U	P/ASSEMBLY	/ATTACHME	NT AND CH	ECKOUT)	
	DATE(S)	1991	INT. HRS _		EVA HRS _		EVA CREW	
	_		. <u>-</u>				-	
	☐ NOT	APF LICABLI	E					
2.	SERVICE (E.G., REPLEI	NISH/RESUPF	LY)				
	INTERVAL	180 DA	YS TOT.	AL SERVICES	20	_		
	TMS/	OTV REQUI	RED		STA	TION HRS P	ER SERVICE	
	□ NOT	APPLICABLI	<u> </u>		EVA	HRS PER SI	ERVICE	5
					EVA	CREW SIZE	:	1
3.	STATION O	PERATION	AL SUPPORT	(AVG. TIME	FOR MONITO	R, INSPECT	, ETC.)	
	0.1	HRS PER DA	AY (INTERNA	AL)				
		HRŞ PER D		•				
	□ NOT	APPLICABLI	E					
4.	RECONFIG	URATION						
	INTERVAL	DA	YS TO	TAL RECONF	IGS.			
	TMS/	OTV REQUI	RED		STAT	ION HRS PE	R RECONFI	G
	⊠ NOT	APPLICABLI	1		EVA	HRS PER RE	CONFIG.	
					EVA	CREW SIZE		
5.	DEACTIVA	TION/REMO	VAL					
	DATE(S)		INT. HRS	<u> </u>	EVA HRS	E	EVA CREW _	
	▼ NOT	APPLICABLI	- E		_		•	
6.	NOTES (BR	IEFLY DESC	RIBE TASKS	IN 1 THROU	GH 5 ABOVE	3)		
1 2 3 4 5	. 5 hou . Opera . Recon	rs 2 tim tional s figurati	mes a yea Support f on inher	s in 199 r are al or exami ent in s past yea	located nation a ervicing	for samp nd measu	le place	Station OPS ement/retrieval

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2003

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Materials and Coatings

Reference Documents:

1. Technology Development Missions, NASA Space Station NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982, attachment A, p 67

Narrative:

Payload element objective, description, EVA reasons, and special considerations are based on Ref 1.

All other data is derived.

Code: GDCD 2003 PAYLOAD ELEMENT SYNTHESIS

MATERIALS AND COATING TECHNOLOGY

I. Mission Objective

To provide a technology base for the production of structural and insulating materials, and optical, thermal, and absorbing surface coatings capable of sustained performance in the space environment.

II. Mission Description

Data will be obtained on the effect of given characteristics of the space environment on critical physical properities of materials and coatings anticipated for use in future space projects. Specific areas of investigation include the degradation of the reflectivity of mirror/antenna metallic coatings as well as the decrease in the absorbtivity of low-scatter optical black surfaces when exposed to solar illumination and solar wind/cosmic ray high energy particle fluxes. Meteoroid venting of the interstitial spaces of thermal insulating materials; decreases in the Young's Modulus of resin-matrix structural composite materials due to cosmic-ray damage and vacuum effects; and particle contamination of the thermal-control coatings applied to heat pipes are also technological concerns. The developed Mission facility will also have the capbility for investigations in the area of space polymer chemistry.

III. Benefit

Since the proposed investigation is involved with common materials and coatings used in varied components of future space missions, the resulting data will be instrumental in developing the enabling technology associated with same missions.

IV. Justification

Based on the Mission specifications, it is apparent that the fundamental requirement for mission operation is long-term exposure to the particle and radiation fluxes only obtained the space vacuum environment. A multi-year Mission lifetime will allow the establishment of time-integrated cumulative effects on the measured physical parameters. Such a procedure represents a substantial improvement over the time-accelerated ground-based testing. Due to the large number of material/coating subsystems comprising the total mission, manned interaction is needed for control and data acquistion.

Page 3 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2003 PAYLOAD ELEMENT SYNTHESIS

V. <u>Mission Requirements and Capabilites</u>

- A) Orbital Parameters- Orbit altitude and inclination angle will be chosen to allow the requsite solar illumination and high-energy particle flow rate.
- B) Mass, Volume, Operational Envelope- Due to the large dimensions anticipated for the surface coatings used in future space projects, the area of the samples investigated in the proposed Mission must be on the order of many square meters.
- C) Power- The power requirements will depend upon the exact characteristics of the subsystem technology and measurement devices employed.
- D) Thermal Control- TBD
- E) Attitude, Stabilization- Since optical spectrometers of high positional sensitivity will be utilized in the reflectivity and absorbtivity measurements, a high degree of stability will be required of the space station.
- F) Viewing- See comment on Orbital Parameters.
- G) Environmental Constraints- none.
- H,I,J) Data Management, Communications, Crew Timeline, Operations Schedule, Maintenance, Lifetime- TBD

VI. Space Station vs. Free Flyer

Due to the large physical dimensions, long timescale, and diverse subsystem experiments requiring manned interaction, characteristic of this Mission, it can be argued that a space station would be the most suitable location for the mission operation.

property

		Page 1 of
PAYLOAD ELEMENT NAME Thermal Shape Control	CODE G D C D 2 O O 4	
CONTACT W. Hardy/J. Peterson MZ 21-9530		Science & Applications
Addrass P.O. Box 85357		(non-commercial)
San Diego		Commercia!
Telephone (619) 277-8900, Ext. 3778/2130		X Tachnology
STATUS		
nal	7	□ Operations
☐ Approved ☐ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	late unity	Typo Numbor
First flight, yr 1993		(see Table A)
No. of flights 1 550 Duration of Flight, days		Importance of the
		يد
To determine the feasibility of controlling shape distortion by onboard heating.		1 = low calus but could use
		Scale 1 - 10 9
DESCRIPTION		
A large flexible panel will be attached to the Space Station. Heaters will be mounted to the panel at a number of locations. Sensors located on the panel will detect deviations from the	e Space Station. Head on the namel wil	aters will be mounted to the
required shape and trigger the heaters to generate which will offset the unwanted distortions.	erate a temperature	a temperature distribution in the panel

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Page 2 of 3			Continuous		
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	km LEO	50 lar	u Frequen	QULY CKI Req	g1tg
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	ORBIT CHARACTERIS Apogee, km LEO Inclination, deg Nodal Angle, deg Escape do Require	POINTING/ORIENTA' Ulaw direction Truth Sites (if) Pointing accuracy Pointing Stabili Special Restrict	AC Derati tandby	DATA/COMMUNICATIONS Monitoring requirements: None XRealtime Encryption/Decryption Uplink Req.: Command R On-Board Data Process	Data Types! Film (Amount Live TU (Hrs On-Board Sto Data Dump Fr

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THERMAL Herman Temperature, deg C operational min
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IREMENTS
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SPECIAL CONSIDERATIONS/Soo Instructions

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2004	ELEMENT NAME	THERMAL	SHAPE	CONTROL	
ACCOMODATION: 💢 ATTA	ACHED	E FLYER	□ 0TV 0)PS	•
1. STATION ACTIVATION (E.G.	, SET-UP/ASSEMBL	//ATTACHME	NT ANÚ CI	HECKOUT)	
DATE(S) 1993 INT.	HRS	EVA HRS	12	_ EVA CREW	_2
		. <u> </u>		_	
NOT APPLICABLE					
2. SERVICE (E.G., REPLENISH/	RESUPPLY)				
INTERVAL DAYS	TOTAL SERVICE	s	_		
TMS/OTV REQUIRED_		STAT	TION HRS	PER SERVICE	
■ NOT APPLICABLE _		EVA	HRS PER	SERVICE	
		EVA	CREW SIZ	E	
3. STATION OPERATIONAL SU	PPORT (AVG. TIME	FOR MONITO	R, INSPEC	T, ETC.)	
0.1 HRS PER DAY (IN	ITERNAL)				
HRS PER DAY (E	VA)				
☐ NOT APPLICABLE					
4. RECONFIGURATION					
INTERVAL DAYS	TOTAL RECON	FIGS			
TMS/OTV REQUIRED		STAT	ION HRS P	ER RECONFI	G
☑ NOT APPLICABLE		EVA I	IRS PER R	ECONFIG.	
		EVA (CREW SIZE		
5. DEACTIVATION/REMOVAL					
DATE(S)1994 INT.	HRS.	EVA HRS	4	EVA CREW _	2
				.	
☐ NOT APPLICABLE					
6. NOTES (SRIEFLY DESCRIBE	TASKS IN 1 THROU	IGH 5 ABOVE)	•		
 Assembly and checomes Operational suppos Removal of panels 	ort for contr	ol and me	asurem	ent	

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2004

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Thermal Shape Control

Reference Documents:

 Technology Development Missions, Space Station NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982

Narrative:

Payload element objective, description, and EVA reasons are based on Ref 1.
All other data is derived.

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Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2004

PAYLOAD ELEMENT SYNTHESIS

Mission Title: Spacecraft Control Technology Development

Langley Contact: H. M. Adelman

Experiment Title: Thermal Shape Control Technology

Mission Objectives: Determine the feasibility of controlling shape distortion by on-board heating.

Mission Description: A large flexible panel will be attached to the space Station. Heaters will be mounted to the panel at a number of locations. Sensors located on the panel will detect deviations from the required shape and trigger the heaters to generate a temperature distribution in the panel which will offset the unwanted distortions.

Benefit: Control of distortions by thermal means has these benefits relative to control by applied forces: Thermal loads are self-equilibrating and their use avoids possible drift and orientation changes associated with unbalanced forces; solar heating and on-board generated heat is available to activate the heaters; the stresses in the panel resulting from the heat loads would be smaller than those associated with applied forces.

Justification: Verification of the concept of thermal shape control requires a long duration mission in a low-g environment. Ground tests and Shuttle flight tests are precluded because of inadequate facilities to simulate precise conditions of sustained orbital heating and to accommodate the large-sized test article required.

Mission Requirements and Capability: The experiment requires a highly variable thermal load environment characteristic of low earth orbit with periodic shading of the panel by the space Station.

C					"							
Page 1 of	TYPE	Applications (non-commercial)	Commercial	X Technology Development	Operations	Type Number 10	Importance of the Space Station to	this Element	could use	Scale 1 - 10 8	d using Space Station as ynamic inputs Would be pro-tory. Experiment duration may ed and expanded. Total of	
	PAYLOAD ELEMENT NAME Dynamics of Flimsy Structures 6 0 0 0 5	CONTACT W. Hardy/J. Peterson MZ 21-9530 Name General Dynamics Convair Division	San Diego, CA 92138	Telephone (619) 277-8900, Ext. 3778/2130	STATUS Operational Planned Approved	70	اعدا	OBJECTIVE Determine dynamic characteristics of large structural systems for use in orbital opeations where static load	requirements are small. The dynamic stittness and damping characteristics of structures such as antenna dishes and manipulator systems which would be nonfunctional in 1-g will be	studied.	DESCRIPTION Candidate structures would be deployed or erected using Space Station as stable platform. General size class would be 30 to 100 meters. Dynamic inputs would be provided and response data measured using Space Station as a laboratory. Experiment duration may be one week or more per test period as the structures are modified and expanded. Total of 4 year mission time.	

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GDE GD CD 2 0 0 5 Page 2 of 3	Tolerance + Ephemeris Accuracy, m	Earth			Duration, hrs/day	Continuous	her Frequency (MHZ)	Voice (Hrs/Day) Other Downlink Frequency (MHZ)
ERISTICS	Any Any	WTATION I Inertial Solar	Stability (Jitter)arc sec/sec Restrictions (Avoidance)	JAC 🗆 DC	1000 Power, W	Peak 1000 Frequence, Hz	MUNICATIONS ng requirements! Realtime XOf Ption/Decryption Requirent Requirement Requireme	Data Types: Analog Digital OF IIM (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 1.0 Downlin)

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CODE 6.0, C, D, 2, 0, 0, 5, Page 3 of		H, M 2.5 Stowed Stowed Stowed Stowed Beployed	nt Monitor Str	Hra/FUA 58	es, kg	Man/Hrs Roq.	be required. 10 day experiment time titions). Used by experiments GDCD 2:
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GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2005 E	LEMENT NAME	DYNAMIC	S OF FLII	MSY STRUC	TURES	
ACCOMODATION: X ATTACH	ED 🗆 FREE	FLYER	OTV OP	rs		
1. STATION ACTIVATION (E.G., SE	T-UP/ASSEMBLY/	ATTACHME	ENT AND CH	ECKOUT)		
DATE(S) 1994 INT. HR	rs	EVA HRS_	50	EVA CREW_	_2	
		-				
NOT APPLICABLE						
2. SERVICE (E.G., REPLENISH/RES	SUPPLY)					
INTERVALDAYS T	TOTAL SERVICES		_			
TMS/OTV REQUIRED		STA	TION HRS PE	ER SERVICE		
■ NOT APPLICABLE		EV	A HRS PER SE	RVICE		
		EV	A CREW SIZE	•		
3. STATION OPERATIONAL SUPPO	RT (AVG. TIME F	OR MONIT	OR, INSPECT	, ETC.)		
0.1 HRS PER DAY (INTE	RNAL)					
HRS PER DAY (EVA)				• .		
☐ NOT APPLICABLE						
4. RECONFIGURATION						
INTERVAL DAYS	TOTAL RECONF	IGS				
TMS/OTV REQUIRED		STA	TION HRS PE	R RECONFIG	•	
NOT APPLICABLE		EVA	HRS PER RE	CONFIG		
		EVA	CREW SIZE	-		
5. DEACTIVATION/REMOVAL			~			
DATE(S) 1998 INT. HR	c	S PRHAVE	3 =	VA CREW	2	
	· ·		· · · · ·			
☐ NOT APPLICABLE		-				
6. NOTES (BRIEFLY DESCRIBE TA	SKS IN 1 THROUG	GH 5 ABOV	E)			
 4 years span time 0perational support Prepare structure 	t for contro	ol and n	D-2201, neasureme	2202, 220 nt	03, 2204,	2502

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2005

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Dynamics of Flimsy Structures

Reference Documents:

1. Technology Development Missions Space Station NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982, attachment A p 40

2. GDC Report CASD-ASP77-017, "SCAFEDS Final Report", Vol. II, Study Results", 26 May 1978

Narrative:

Payload element flight duration, objective, description, and EVA reasons are based on Ref 1.

The test structure size of 100 by 20 by 2.5 meters is based on Ref 1. The structure design is based on SCAFEDS technology and employs graphite composite truses built in space by a Beam Builder machine (Ref 2).

The mass of the Beam Builder, assembly fixtures, etc., is not included in the mass estimate in the payload element data sheets.

Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2005

PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title:

Langley Contact:

B. R. Hanks

Space Structures Technology Development--Static/Dynamic Testing

Experiment Title:

Dynamics of Lightly Loaded Structures

Mission Objectives:

Determine dynamic characteristics of large structural systems for use in orbital operations where static load requirements are small. The dynamic stiffness and damping characteristics of structures such as antenna dishes and manipulator systems which would be non-functional in 1-G will be studied.

Mission Description:

Candidate structures would be deployed or erected using space station as stable platform. General size class would be 30-100 m. Dynamic inputs would be provided and response data measured using space station as a laboratory. Experiment duration may be one week or more.

Benefit:

Building orbiting space structures of anything other than flimsy components may be unnecessary provided sufficient confidence in such components can be developed in flight experiments. Substantial reductions in launch costs and increases in the utility of large spacecraft may be realized through the use of ultra-light structures.

Justification:

For stated benefits to accrue, methods of predicting large dynamic motions and behavior of flimsy structures are needed. The inherent effects of gravity make any Earth-bound study of such structures invalid. The sizes required preclude O-G aircraft flights.

Mission Requirements and Capability:

Requires 0-G test environment for one week or more. Structural sizes up to 100m involved for up to one week or more. Space station mounted optical measurement devices are necessary.

Space Station vs. Free Flyer:

Space station provides controlled base from which measurements are made. Eliminates need for flight control system which would likely be difficult or impossible to preclude from adverse effects on experiment. Reduces cost considerably.

(+

ciated cryogenic engineering; microwave receivers, and optical fibers will also be addressed.

Page 1 of ed by astronomical observations, technological issues relating to infrared detectors and asso-**DESCRIPTION** The proposed mission will investigate critical technological issues germane to the truss support structure for the primary mirror; and, accurate angular pointing of the antenna assembly. Since the technological readiness of the assembled reflector will be confirmactuators and control algorithms; measurement of optical image quality through wavefront sensing and laser ranging techniques; deployment, erection, and mechanical vibration control of experimentation are maintenance of surface figure and segment orientation through positional the use of large multi-segmented active reflectors in future space projects. Key areas of (non-commercial) 1 - low value but Applications Importance of the Space Station to Dovelopment (See Table A) could use X Tachnology Operations Commercia! Scale 1 - 10 this Eloment Science & Type Number 10 - vital TYPE 900 tion of large-aperture segmented mirrors having high surface To provide a technology base for the operation and construc-**CODE** 6 0 c 0 2 Opportunity X Candidate Delanned 1000 General Dynamics Convair Division W. Hardy/J. Peterson MZ 21-9530 (619) 277-8900, Ext. 3778/2130 Flight, days San Diego, CA 92138 First flight, yr 1994 P.O. Box 85357 PAYLOAD ELEMENT NAME Active Optics Technology accuracy optical figure. □ Operational Approved No. of flights Duration of Telephone OBJECTIVE Addross CONTACT STATUS Nego

ORIGINAL PAGE 19 OF POOR QUALITY

G D C D 2 0 0 6 Page 2 of 3		Solar Earth Field of view, deg	U Duration, hrs/day ☐Continuous	□Othar Fraquency (MHZ)	Digital Hrs/Day Voice (Hrs/Day) Other Other Marx
	ORBIT CHARACTERISTICS Apogee, km LEO Perigee, km Inclination, deg Any Nodal Angle, deg	POINTING/ORIENTATION Usew direction Inertial Truth Sites (If known) Pointing accuracy, arc sec Pointing Stability (Jitter) arc Special Restrictions (Avoidance	rating ndby k	DATA/COMMUNICATIONS Monitoring requirements: None None Encryption/Decryption Required Uplink Req.:Command Rate (KBS) On-Board Data Processing Required Description	Data Types: Analog Dir Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit)

GDE CD2006 Page 3 of 3		Stowed 12 Stowed 10,000 Cryogens	Hrs/EUA 58	Rog.	O arc seconds. Provides tech- reflector.
	THERMAL ———————————————————————————————————	Remote Lynnpressur 12 H, m	Crew Size Skills (See Table B) LEUEL Hrs/Day EUA NVES Organiant SKILL 7 LEUEL A 7 LEUEL A 7 LEUEL A 7 LEUEL A 7 LEUEL A 7 LEUEL A 7 LEUEL A 8 5 9 / Service/Remove e	taintenance 180 consumables, turnables, kg Man Hours 10N CHANGES:Interval, day Deliverables, kg ASIDERATIONS/See Instructions	Payload equipment will provide own pointing accuracy of 0.5 to 20 arc seconds. Provides tech- nology base for space telescope systems such as large deployable reflector.

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2006 ELEMENT NAME AC	TIVE OPTICS TECHNOLOGY
ACCOMODATION: X ATTACHED TREE FLY	ER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATT	ACHMENT AND CHECKOUT)
DATE(S) 1994 INT. HRS 12 EVA	HRS 24 EVA CREW 2
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 180 DAYS TOTAL SERVICES	<u> </u>
TMS/OTV REQUIRED	STATION HRS PER SERVICE2
☐ NOT APPLICABLE	EVA HRS PER SERVICE 2
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR M	IONITOR, INSPECT, ETC.)
0.2 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
☐ NOT APPLICABLE.	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONFIGS.	
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) 1996 INT. HRS. 12 EVA F	IRS 24 FVACREW 2
on the state of th	
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	ABOVE)
1. Assembly of mirror segments/back-	up structure, mirror and positional
actuators, secondary mirrior and 2. Replenish cryogens	instruments
3. Evaluate mirror surface accuracy,	observe long term effects and take
astronomical data 5. Disassembly - see 1. above	

TOTAL EVA HRS _____58

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2006

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Active Optics Technology

Reference Documents:

- 1. Technology Development Missions, Space Station NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982
- 2. Astrophysics Long-Term Program, GDC Document No. 10-004N, October 1980

Narrative:

General concept, timing, thermal design, and crew activities from Ref 1. Orbit parameters, orientation, size, and consumables from Ref 2. Mass derived from Ref 2 without spacecraft systems. Pointing capability from Ref 2.

All other data derived.

Page 2 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2006

PAYLOAD ELEMENT SYNTHESIS

ACTIVE OPTICS TECHNOLOGY

I. Mission Objectives

To provide a technology base for the operation and construction of large-aperture segmented mirrors having high surface accuracy optical figure.

II. <u>Mission Description</u>

The proposed mission will investigate critical technological issues germane to the use of large multi-segmented active reflectors in future space projects. Key areas of experimentation are maintenance of surface figure and segment orientation through positional accuators and control algorithms; measurement of optical image quality through wavefront sensing and laser ranging techniques; deployment, erection, and mechanical vibration control of the truss support structure for the primary mirror; and, accurate angular pointing of the antenna assembly. Since the technological readiness of the assembled reflector will be confirmed by astronomical observations, technological issues relating to infrared detectors and associated cyrogenic engineering; microwave recievers, and optical fibers will also be addressed.

III. Benefit

Due to the generic nature of the optical technology research comprising the proposed mission, the results will be applicable to several types of NASA advanced space projects. Future high-spatial resolution remote sensing of earth resources and environmental conditions will require large diameter active reflectors. An active space-optics technological base will also be required for high bit-rate microwave communication antennae used on planetary spacecraft; solar heat collecting mirrors; and space telescope systems such as LDR, the Large Deployable Reflector.

IV. Justification

The Active Optics Technology Mission will require a prolonged time exposure to the space environment. Low gravity conditions are needed to insure realistic/useful technological data as well as to investigate capillary confinement techniques used to contain cyrogenic fluids. In order to demonstrate the lifetime of positional and accuating active mirror components and to investigate the time-integrated effects of particle radiation damage of infrared detectors, the Mission should have a several year duration. Optical technology concerns specifically related to the environment of space include the thermal deformation of the mirror figure due to solar illumination; the effect of solar wind torques on reflector pointing; and the effect of a vacuum on

Page 3 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2006

PAYLOAD ELEMENT SYNTHESIS

resin-matrix structural composites. Manned interaction will be necessary for mission operation in the following areas: deployment and initial alignment of mirror panels and back-up structure; control of subsystem experiments; and development of the astronomical observing program.

V. Mission Requirements and Capabilities

- A) Orbital Parameters- Orbit altitude and inclination angle should be chosen to maximize the potential of the astronomical observations.
- B) Mass, Volume, Operational Envelope- In order to allow reasonable scaling of the technological data obtained in this mission, the test mirror should be composed of several panels each 1-4 meters in diameter.
- C) Power- The power requirements are dependent upon the specific details of the instruments employed.
- D) Thermal Control- Thermal insulation on the rear surface of the mirror panels and a passive sunshield will be used to regulate the reflector temperature. The space station need not provide thermal control.
- E) Attitude, Stabilization- A high degree of positional stability will be required in order to make possible accurate wavefront contour measurements, CCD star tracker testing, laser ranging technology evaluation, and astronomical observations.
- F) Viewing- see comment on Orbital Parameters
- G) Environmental Constaints- none
- H,I) Data Management, Communications, Crew Timeline- TBD
- J) Operations Schedule, Maintenance, Lifetime- For the reasons detailed in section IV, a several year Mission lifetime is required.

VI. Space Station vs. Free Flyer

Due to the large physical dimensions, long timescale, and diverse subsystem experiments requiring manned interaction, characteristic of this Mission, it can be argued that a space station would be the most suitable location for the mission operation.

and the state of the state to

PAYLOAD ELEMENT NAME Large Structures Technology CONTACT W. Hardv/J. Peterson MZ 21-9530	-
Structures lechnology 9CT W. Hardv/J. Peterson MZ 21-9530	TYPE
ACT W. Hardv/J. Peterson MZ 21-9530	Science &
Hddrdss P.O. Box 85357 San Diego, CA 92138	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	X Tachnology Development
STATUS Decrational Delanned	Operations
☐ Approved [X] Candidate ☐ Opportunity	Number
First flight, yr 2002 No. of flights 1 1100+ Duration of Flight, days	Importance of the Space Station to
OBJECTIVE To provide a technology base for the design and analysis of very large space structures having dimensions larger than are compatible with Space Shuttle experiments.	this Element 1. Tow value but could use
	Scale 1 - 10 10
Assembly and testing of very large space structures will require utilization of the Space Station as a base for these activities. Maintaining a long lifetime stable platform for assembly and inertial structural characterization testing is important for the evolution of large structures technology. A large facility that can be used for assembly and environmental testing would be required on the Space Station. This facility would include data acquisition and analysis capabilities, mechanical operations support and maintenance capabilities, and a supply of goods and tools to allow modifications to large structure designs while on-orbit. Complete dynamic testing capabilities will be required to determine mode shapes, inertial properties, damping/influence coefficients, and other design parameters necessary to characterize the stability and dynamics of very large space structures. Payload based on SCAFEDS technology.	Space Station as a base for these ructural characterization testing is n be used for assembly and environata acquisition and analysis capafoods and tools to allow modifities will be required to determine arameters necessary to characterize technology.

ORIGINAL PAGE IS OF POOR QUALITY

CODE 6.0 C.0 2 0.0 7 Pege 2 of 3
km LEO Tolorance + Ephemeris Ac
ENTA
بد ب
OUER MAC Do Power, U Duration, hrs/day
Peak 1000 Frequency, Hz
UNICATIONS g requirements! Realtime XOf ption/Decryption Requir R Req.! Command Rate (Ki and Data Processing Req
Data Types! Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) Downlink Frequency (MHZ)

е		ORIGHTAL OF POOR	Constitution	Дррениіх 1
CODE 6.0.0.0.7 Page 3 of 3	Gg C operational min max non-operational min max non-operational min max non-operational min max	PHYSICAL CHARACTERISTICS Internal External Remote ID/Function Pressurized Unpressurized L,m 1000 U,m 200 H,m 5 Deployed Launch mass, kg Consumables Tupes	Task Assignment Structural Testing SKILL 1 1 LEVEL 2 2 Hrs/Day 0.2 0.2 Reason Fabrication Hrs/EVA 1500	Man/Hrs Roq. Returnables, kg n orbit for solar eclipses (theration. Mass and volume thousands pe could be many km. A stable ion from the Space Station pernalysis farility would be rest the large structures. Testing teams on the ground would require
	THERMAL Active Tomporature, d Heat Rejection	EQUIPMENT Location: Equipment	CREU REQUIRE Crew Size Skills (See EUA XYES SERUICING/MA	CONFIGURATE CONFIGURATE COMPINE SHOCK), of kg, could platform is turbations quired. Pay coordinatio detailed ev

*

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

30CD CODE	ELEMENT	NAME LARGE ST	RUCTURES TECHN	OLOGY
ACCOMODATION:	▲ ATTACHED	FREE FLYER (□ OTV OPS	
I. STATION ACTIVAT	ION (E.G., SET-UP/ASSE	EMBLY/ATTACHMEN	T AND CHECKOUT)	
DATE(S) 2002	INT. HRS	EVA HRS1	SOO EVA CREW	2
□ NOT APPLICA				
2. SERVICE (E.G., REP	LENISH/RESUPPLY)			
INTERVAL	DAYS TOTAL SE	RVICES		
TMS/OTV REG	QUIRED	STATI	ON HRS PER SERVICE	
M NOT APPLICA	BLE	EVA H	RS PER SERVICE	
		EVA C	REW SIZE	
HRS PEI NOT APPLICA RECONFIGURATION INTERVAL TMS/OTV REC	BLE N Days total R		 ON HRS PER RECONFI	G
☑ NOT APPLICA	8LE	EVA HI	RS PER RECONFIG.	
		EVA C	REW SIZE	
5. DEACTIVATION/RE	MOVAL			
DATE(S)	INT. HRS	EVA !! RS	EVA CREW	
■ NOT APPLICA	BLE			
	ESCRIBE TASKS IN 1 T		od.	

- 3. Allocation for testing and evaluation5. Platform remains in operation

Page 1 of 4 Volume II, Book 1 Appendix I

Code: GDCD 2007

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Large Structures Technology

Reference Documents:

- 1. Technology Development Missions, Space Station NAAO Orientation meeting NASA Hq., 14-15 Sept 1982
- 2. NASA Hq. Viewgraph, MT 79-2713(1), 6/11/79
- 3. Orbital Assembly and Maintenance Study, Final Report, August 1975 Martin Marietta Report MCR -75-319, Contract No. NASA -14319.
- 4. GDC Report CASD-ASP77-017, "SCAFEDS Final Report, 1 II, Study Results", 26 May 1978

Narrative:

Payload element objective, description, skill type, specimen considerations, and nominal length are based on Ref 1.

The EVA time estimate is based on Ref 2 using beam building concept, or Ref 3 using erection concept for shuttle delivered pre-fabricated structure.

All other data is derived. (The originator of the P/L element was contacted.)

The test structure size of 1000 by 200 by 5 meters is based on Ref 1. The structure design is based on SCAFEDS technology (Ref 4). The mass is scaled from SCAFEDS technology at 0.5 kg/m 2 . The Beam Builders and associated assembly fixtures are not included in this mass estimate.

Page 2 of 4 Volume II, Book 1 Appendix I

Code: GDCD 2007

PAYLOAD ELEMENT SYNTHESIS

LARGE STRUCTURES TECHNOLOGY EXPERIMENTS

I. Mission Objective

To provide a technology base for the design and analysis of very large space structures having dimensions larger than are compatible with Space Shuttle experiments.

II. Mission Description

Assembly and testing of very large space structures will require utilization of the Space Station as a base for these activities. Maintaining a long lifetime stable platform for assembly and inertial structural characterization testing is important for the evolution of large structure technology. A large facility that can be used for assembly and environmental testing would be required on the Space Station. This facility would include data acquistion and analysis capabilities mechanical operations support and maintenance capabilities, and a supply of goods and tools to allow modifications to large structure designs while on-orbit. Complete dynamic testing capabilities will be required to determine mode shapes, inertial properties, damping/influence coefficients, and other design parameters necessary to characterize the stability and dynamics of very large space structures.

III. Benefit

Many future manned and unmanned missions will depend on assembly and testing of very large space structures enabling new design concepts for structures having kilometer dimensions.

IV. Justification

The long duration, low gravity, and stability characteristics of the Space Station will be an ideal base for the assembly and testing of very large space structures. The inevitability of the very large space structures as a basis for future space missions is certain.

V. <u>Mission Requirements & Capabilities</u>

- A) Orbital Parameters Low inclination for certain thermal shock experimental missions during solar eclipse. High inclination for long term thermal stabilization (no eclipses) during other experimental missions. High altitude to minimize drag perturbations on large structures.
- B) Mass, volume, operational envelope is TBD. Mass of components requiring assembly (many thousands of kilograms) could necessitate multi-shuttle launchs. Volume requirements for materials could also require multiple launches. Operational envelope could be many kilometers in dimension requiring some kind of EVA/Teleoperator system.

Code: GDCD 2007

PAYLOAD ELEMENT SYNTHESIS

- C) Power The power requirements would be in the many kilowatt range to allow the assembly and testing activities.
- D) Thermal Control No requirements identified
- E) Attitude, Stabilization A stable platform is necessary for assembly and some testing. Possible isolation from the Space Station perturbations may be necessary during structural dynamics testing. This may be accomplished using either a free-flyer concept or a tether.
- F) Viewing No requirements identified.
- G) Environmental Constraints Low g environment free from micro-g perturbations.
- H) Data Management, Communications A data acquisition and analysis facility would be required to gather and interpret the structural assembly and testing experiments in real time. A communications link would either be hard wired if the structure were attached to the Space Station (or on a tether), or an RF link would be necessary from a free flyer to the data facility on the Space Station.
- I) Crew Timeline Payload specialists would be trained to assemble and test the large structures. Testing coordination between the onboard data facility and engineering teams on the ground would require detailed event timelines to assure the adequacy and completeness of the tests and iterations required.
- J) Operations Schedule, Maintenance, Lifetime TBD

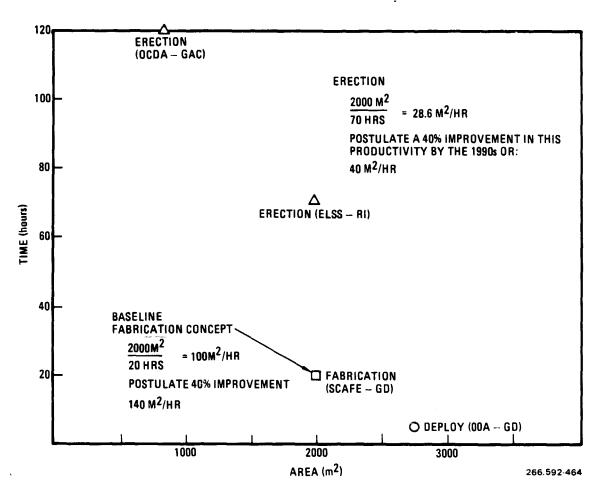
VI. Space Station vs. Free Flyer

If the stability of the Space Station can be controlled precisely (e.g. TBD) enough, some testing might be possible while attached to the Station. Some testing will probably require isolation from the Station either using Lether system or a free flyer concept.

Code: GDCD 2007

PAYLOAD ELEMENT SYNTHESIS

Derived from Ref 2.



Productivity of Space Construction Techniques

Section	3.2

Discipline Energy Conversion

GDCD ID NO.	PAYLOAD ELEMENT NAME
2101	Low-Cost Modular Solar Panels
2102	Reserved
2103	Ion Effects on LEO Power Systems
2104	Large Solar Concentrator
2105	Solar Pumped Lasers
2106	Laser/Electric Energy Conversion
2107	Solar Sustained Plasmas
2108	Space Nuclear Reactor

		C 10 7 251
	CODE	TYPE
Modular Solar Panels		Science &
n MZ 21-9530 nvair Division		Applications (non-commercial)
San Diego, CA 92138		
Telephone (619) 277-8900, Ext. 3778/2130		Technology
STATUS		
Operational Operational	9	Operations
☐ Approved ☐ ☐ Opportunity	ate	Type Number
		(See Table A)
No. of flights 1 Duration of Flight, days 3650+		Importance of the
OBJECTIVE To provide the technology development and demon-	Γ	this Eloment
stration of spacecraft solar panels that embody features that		
allow them to be low cost, but nearly as long-lasting and effi-	ffi-	and punch won a
cient as turrent panels. The solar panels would incorporate prodular design features to allow easy replacement of malfunc-		10 - oftal
tioning sections. Array output voltage would be variable to test	est	
plasma effects.		Scale 1 - 10
DESCRIPTION This mission would provide testing and demonstration of the technology for design and manufacture of low cost solar panels. Their cost would be greatly reduced by the	ng and demonstration s. Their cost would	n of the technology for be greatly reduced by the
use of design features suitable for space, but with application of commercial standards used for the production of reliable earth-based solar panels. The Space Station makes possible the	with application of an panels. The Space	f commercial standards used
continuous, long-term test in parallel of several candidate solar panel and power system de-	ral candidate solar	panel and power system de-
signs, in real conditions. It makes available the space vacuum, the orbital radiation environ-	the space vacuum, the	ne orbital radiation environ-
solar panels must ensure and the plasma effect:	equent of bluar ecrit s on high voltage an	cycling of continuous, frequent of Dital eclipses. The themal cycling that Isure and the plasma effects on high voltage arrays are among the most im-
portant and least understood causes of solar panel failure. This mission would allow us to	anel failure. This n	nission would allow us to
understand the causes of these fallures.		

m		}	T		, , , , , , , , , , , , , , , , , , ,
CODE GDCD2101 Page 2 of	Apogee, km LEO Perigee, km LEO Tolerance + Inclination, deg Any Tolerance + Tolerance + Standard Any Ephemeris Accuracy, m	IL L	OUER Ac Operating Standby Peak	MUNICATIONS ng requirements: Realtime XOf Yetion / Decryption Requirent NK Req.: Command Rate (K) Oard Data Processing Requirent Command Rate (K) Comma	Data Types: Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

THERMAL THERMAL Tomperature, deg C operational min max Heat Rejection, w operational min max Heat Rejection, w operational min max Heat Rejection, w operational min max EQUIPMENT PHYSICAL CHARACTERISTICS Location: Internal External Remote Equipment ID/Function Pressurized Unpressurized L,m 5 U,m 6 H,m 0.1 Equipment ID/Function L,m 5 U,m 6 H,m 0.1 Consumables Vgres Consumables Vgres Consumables Vgres Consumables Vgres Consumables Vgres SKILLS (See Table B) SKILL 1 ELEVEL I Nonitor Specimen Condition SKILLS (See Table B) EKILL 1 ELEVEL I Nonitor Specimen Condition SKILLS (See Table B) EKILL 1 EVEL REQUIREMENTENANCE SERVICING/MAINTENANCE SERVICING/MAINTEN	Passive operational min non-operational min operational min non-operational min non-operational min New CHARACTERISTICS Nal
onal min onal min onal min onal min onal min nax onal min nax onal min nax onal min nax TICS strat U,m 6 H,m 0.1 Types Types Types Types Types Types Types Types Types Types Types Types Types Task Assignment Monitor Specimen Consumables, kg Man Hours Man Hours Tagy Solutions Tagy Types T	tion, w operational min max non-operational min max non-operational min max PHYSICAL CHARACTERISTICS Internal External Remota ID/Function PressurizedEUnpressurized L,m 5 U,m 6 H,m 0.1 L,m 5 U,m 6 H,m 0.1 Consumables Types Consumables Types Acceleration sensitivity, g min max REMENTS Task Assignment Monitor Specimen Hrs/Day 0.1
TICS surized Unpressurized U, m U, m E H, m O.1 Lypes rypes rypes n Sensitivity, g min max Task Assignment Monitor Specimen L 1 Day O.1 Replace Panels Hrs/EVA Ann Hours day lg0 Returnables, kg tructions is for deployed configuration.	L CHARACTERISTICS prnal External Remote 1.mm (1.10) L,m 5 U,m 6 H,m 0.1 Launch mass, kg 6 Consumables Types 6 H,m 30 Consumables Types 6 Consumables Types 7 Consumables Types 7 Consumables Types 8 Consumables Types 8 Consumables Types 8 Min Monitor Specimen 1 Task Assignment Monitor Specimen 1 Hrs/Day 0.1
Lypes Types Types Types Types Types Task Assignment Monitor Specimen L 1 Day 0.1 Nount, Replace Panels Hrs/EVA day 180 Han Hours tructions is for deployed configuration.	L,m 5 U,m 6 H,m 0.5 L,m 5 U,m 6 H,m 0.1 Launch mass, kg Consumables Types Acceleration sensitivity, g min max 1 Task Assignment Monitor Specimen B) SKILL 1 LEVEL 1 Hrs/Day 0.1
Types A sensitivity, g min Task Assignment L	Consumables Types Acceleration sensitivity, g min 1
Task Assignment L 1 1 L 1 Day 0.1 Mount, Replace Panels day day day structions is for deployed configurat	1 Task Assignment B) SKILL 1
Task Assignment L 1 1 Day 0.1 Mount, Replace Panels Consumables, day day 180 bles, kg 30 tructions	B) SKILL 1 LEVEL 1 Hrs/Day 0.1
Day 0.1 n Mount, Replace Panels consumables, Man Hours bles, kg 30 tructions is for deployed configurat	B) SKILL 1 LEVEL 1 Hrs/Day 0.1
Day Day Day Day Day Day Consumables, kg Man Hours Han/Hrs Req. Lructions is for deployed configuration.	LEUEL Hrs/Day
n Mount, Replace Panels Hrs/EUA 12 Consumables, kg day bles, kg tructions is for deployed configuration.	Hrs/Day
Mount, Replace Panels Hrs/EUA 12 Consumables, kg day 180 bles, kg 30 Returnables, kg tructions is for deployed configuration.	
Consumables, kg Man Hours day bles, kg 30 Returnables, kg tructions is for deployed configuration.	n Mount, Replace Panels Hra/FUA
day Hours Han/Hrs Roq. bles, kg 30 Returnables, kg tructions	
day 180 Man/Hrs Req. bles, kg 30 Returnables, kg tructions is for deployed configuration.	Consummables,
bles, kg 30 Returnables, kg tructions	Man Hours
	hing to 30 per 100 per
self-powered. Accel level is for deployed configuration.	IONS/See Instructions
	self-powered. Accel level is for deployed configuration.

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2101 ELEMENT NAME	LOW-COST MODULAR SOLAR PANELS
ACCOMODATION: 🛛 ATTACHED 🗆 FREE	FLYER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/	ATTACHMENT AND CHECKOUT)
DATE(S) 1991 INT. HRS	EVA HRS6 EVA CREW1
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
☑ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME F O.1 HRS PER DAY (INTERNAL) HRS PER DAY (EVA) NOT APPLICABLE 4. RECONFIGURATION INTERVAL 180 DAYS TOTAL RECONFIGURATION TMS/OTV REQUIRED NOT APPLICABLE	
5. DEACTIVATION/REMOVAL	
OATE(S) INT. HRS E	VA HRS EVA CREW
☑ NOT APPLICABLE	·
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH	SH 5 ABOVE)
 Initial placement of solar pan Replacement of panels at 6 mo. Monitoring of panel performance Panels stay in place past year 	intervals. e.

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2101

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Low Cost Modular Solar Panels

Reference Documents:

 Technology Development Missions, NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982

Narrative:

Payload element objective, description and space station accommodations are from Ref 1. Size, weight, and pointing constraints are based on Ref 1.

All other data is derived. Payload element station supported operations are assumed to start as early as possible.

The solar panel size of 150 square meters was felt to be more than required and therefore was reduced to 30 square meters.

Page 2 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2101

PAYLOAD ELEMENT SYNTHESIS

LARGE SPACE POWER SYSTEM TECHNOLOGY DEMONSTRATION

I. Mission Objective

Demonstrate the viability of multi-voltage operational scheme for large, high power space power system for space platforms.

II. Mission Description

A large solar array segment (sized up to 20 KW) will be assembled in modular form capable of generating power at various voltages from 200 to 1000 volts. This power will be brought into a collection system where it will be converted to AC (high frequency) for transmission to a power distributor system at least 50 m away. Transmission will be over several lines. Within the power distributor, the power will be conditioned for users (possibly 120v, 60 cycle).

III. Benefit

The experiment would be an enabling technology experiment, demonstrating the capability of building modularized space power systems to hundreds of kilowatts for operation in the space environment.

IV. Justification

Future space platform missions are projected to require 100 KW and larger power systems. At these high power levels, the operating voltages for the power generators must be increased to minimize harness losses. Operations at elevated voltages results in possible detrimental interactions with the space plasma environment. Hence, a compromise between the operating voltage required to minimize harness losses and voltages to minimize environment losses must be reached. Such a compromise is the proposed D.C. generation, A.C. transmission concept. In this system, power is generated in modularized solar array systems operating at a voltage compatible with environmental interactions, collected and converted to A.C. for transmission over the large distances to the electrical load distribution system.

The proposed experiment would be a verification of design concepts enabling the construction of larger systems. All of the elements of this space power system would be incorporated. The operation in the space plasma environment over extended periods of time would demonstrate the viability of the system and the understanding of plasma interaction concepts. Such an experiment could not be run from the Shuttle due to the system size and length of time required to justify extension to multiyear operations.

Code: GDCD 2101 PAYLOAD ELEMENT SYNTHESIS

V. Mission Requirements & Capabilities

- A) Orbital Parameters Operation in equatorial-like environments at altitudes of 300 to 400km with arbitrary inclination. (Space platform altitudes)
- B) Mass, volume, operational envelope The proposed experiment includes an approximately 15kw solar array divided into 3 circuits. Each of the 5KW blocks of cells is modularized so that the operating voltage can be controlled. From the power generator 3 transmission lines (50m long) run to the power distributor. The DC to AC conversion system will be located at the generator end of the system. Low frequency, A.C. power would be available at the distributor end for use of the space platform.

The mass has not been estimated as yet. The area of the array is about 150 square meters. It is proposed that this system function in sunlight for at least 6 months to complete the interaction evaluation. This includes the orbital eclipse shut-downs.

- C) Power Experiment will provide own power.
- D) Thermal control Self-contained thermal control subsystem.
- E) Attitude, Stabilization Power generator must be sunlit and held in nominal normal solar incidence on solar array.
- F) Viewing No shadowing of array by space structure allowed.
- G) Environmental Constraints System must function in space environment.
- H) Data Management, Communications Output parameters of system will be monitored. All measurements involving high voltage will be conditioned to be compatible with existing command and data systems.
- I) Crew Timeline Not applicable
- J) Operating Schedule, Maintenance, Lifetime It is desired to turn on this system and leave on for a minimum of 6 months. Data will be collected and analyzed. Operational mode changes will be commanded in as appropriate to obtain desired information. (This could be done by automated sequences). There should be no maintenance required.

Ion Effects on LEO Power Systems 6 0 C 0 2 1 0 3	
rumer ayarems	_
	Science &
	Applications (non-commercial)
Hddrass P.O. Box 85357 San Diego, CA 92138	Competition
Telephone (619) 277-8900, Ext. 3778/2130	Development
STATUS	
nal	□ Operations
☐Approved ⊠Candidate ☐Opportunity	Tube Number
1992	(See Table A)
Duration of Flight, days 365	
OBJECTIVE	Г
To obtain essential knowledge on power systems operating in an ion thruster generated plasma plume which is needed for design	-
and development of advanced photovoltaic space power systems	
with high power and high voltage.	
	Scale 1 - 10 9
DESCRIPTION Small prototypes of photovoltaic space power systems will be operated	lower systems will be operated in the
vicinity of an ion thruster in order to gain experimental data. These data will yield basic	il data. These data will yield basic
fects of both environment and ion engine generated plasma environment will be determined	
Power losses, array degradation and electromagnetic interference are of major concern and must	rference are of major concern and mus
be carefully controlled. Data will be obtained for a variety of thruster propellants be useful for array type, size and voltage scaling.	nety of thruster propellants and will
	solar arrays will be analyzed and tested including the effect of modifica
tions incorporating mitigation techniques such as insulating and biasing. Operating constraints	iting and biasing. Operating constraint
such as contiquration and spacing from thrusters must be ted intermittently.	and spacing from thrusters must be determined. Inrusters would be opera-
ירם וווכרוווו רכרורו).	

ORIGINAL PAGE IS

Page 2 of 3							
	8		re allowed.			MH2)	
0 C 0 2 1 0 3	# Apa.		deg	7		Fraquency (MHZ)	
CODE	Tolerance + Ephemeris Accuracy,		y,arc soc 7200 Field of view, dag ty (Jitter)arc soc/soc	Duration, hrs/day			Uoice (Hrs/Day) Other
			Field Sec	Durati	Frequency, Hz	o Cher	Ital Voice
	km LEO	l XSolar	7200 arc sec/sec ance) No shado	Power, U	Freq	XOffline equired e (KBS) g Required	Digital
	Periges, Any	TION Inertial	Hyarc sec 7200 ty (litter)arc	00 D		ACCOMMUNICATIONS Lecting requirements: None Encryption/Decryption Required Uplink Req.: Command Rate (KBS) On-Board Data Processing Required Description	Osi Analog DI(Hrs/Day)
	CHARACTERISTICS , km LEO Peation, deg Angle, deg			1	70 1	MICATIONS requirem requirem Lion/Decri Req.:Com	Types! (Amount) Types! (Amount) Ty (Hrs/De
	ORBIT CHARACTERIST Proges, km LEO Inclination, deg Nodal Angle, deg Escape do Regulres	OINTING/ORIENTA	from Sices in Pointing accurac Pointing Stabili Special Restrict	OUER AC	Peak Voltage, U	DATA/COMMUNICATY Monitoring requi None Encryption/Di Uplink Req.: Description	Date Tuber Con-Board

OR	IGINAL	PAGE	19
OF	POOR	QUALI	TY

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2103	ELEMENT NAME	ION EFFE	CTS ON I	LEO POWER	SYSTEM	
ACCOMODATION: TATT	ACHED	E FLYER	☐ 0TV 0	PS		
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)						
DATE(S) 1992 INT	. HRS	EVA HRS	5	EVA CREW_	1	
		_				
☐ NOT APPLICABLE						
2. SERVICE (E.G., REPLENISH/	RESUPPLY)					
INTERVAL DAYS	TOTAL SERVICE	s	_			
TMS/OTV REQUIRED		STAT	TION HRS P	ER SERVICE _		
☑ NOT APPLICABLE		EVA	HRS PER S	ERVICE _		
		EVA	CREW SIZE			
3. STATION OPERATIONAL SU	IPPORT (AVG. TIME	FOR MONITO	R, INSPECT	, ETC.)		
0.1 HRS PER DAY (II	NTERNAL)					
HRS PER DAY (E	(AV					
☐ NOT APPLICABLE			•			
4. RECONFIGURATION						
INTERVAL 120 DAYS	TOTAL RECON	FIGS. 2				
TMS/OTV REQUIRED		STAT	ION HRS PE	R RECONFIG.		
☐ NOT APPLICABLE		EVA	HRS PER RE	ECONFIG	5	
		EVA	CREW SIZE	_	1	
5. DEACTIVATION/REMOVAL						
DATE(S) 1993 INT.	. HRS	EVA HRS	5 6	VA CREW	1	
		_		-		
☐ NOT APPLICABLE						
6. NOTES (BRIEFLY DESCRIBE	TASKS IN 1 THROU	GH 5 ABOVE)			
 Attach ION engin Monitoring and e Replace ION engi Remove ION engin 	valuation of ne/array - 2	performar trips	ice			

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2103

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: ION Effects on LEO Power Systems

Reference Documents:

- Technology Development Missions, NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982
- 2. Radio-Frequency ION Thruster Assembly For Orbit Control of Geostationary Satellites. MBB.

Narrative:

The payload element objective description and altitude are from Ref 1.

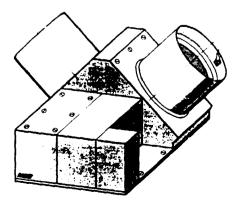
The experiment duration from Ref 1 was extended to 1 year to permit a change in the ION engine package to evaluate effects of a different thurster propellant.

All other data is derived. Weight is estimated for solar array plus 2 ION thruster units.

The following characteristics and sketch are extracted from Ref 2:

"Electric propulsion system for operational applications. This system includes two RIT-10 thrusters and all components for engine and neutralizer operation and control. The thrusters are inclined at 45 degrees to performing both N/S and E/W orbit control.

Compared with RITA-1, RITA-2 is an improved simplified system, with reduced telemetry- and telecommand interfaces by a complete automatic operation and control by microprocessor. Two units are required per satellite to be mounted on the east and west side panels of the spacecraft."



Nominal thrust 10 mN per thruster 5-10 mN Operating range 31 000 Ns/kg Specific impulse Mass of 1 RITA-2 (dry) 25 kg Propellant mass (max.) 10 kg Power input per thruster 350 W One or two thrusters can be operated. Code: GDCD 2103

PAYLOAD ELEMENT SYNTHESIS

ION THRUSTER EFFECTS ON LED POWER SYSTEMS

I. Mission Objectives

To obtain essential knowledge on power systems operating in an ion thruster generated plasma plume which is needed for design and development of advanced photovoltaic space power systems with high power and high voltage.

II. Mission Description

Prototypes of advanced photovoltaic space power systems must be operated in the vicinity of an ion thruster in order to gain essential experimental data. This data will be analyzed to yield basic knowledge about the physical processes and ultimately verification of analytical models and practical power system designs.

The effects of both natural plasma environment and ion engine generated plasma environment must be determined. Power losses, array degradation and electromagnetic interference are of major concern and must be carefully controlled. Data must be obtained for a variety of thruster propellants and useful for array type, size and voltage scaling.

Both plasma and concentrator solar arrays must be analyzed and tested including the effect of modifications incorporating mitigation techniques such as insulating and biasing. Operating constraints such as configuration and spacing from thrusters must be determined.

The effects to be studied are:

- o Pinhole effects at positive potentials, secondary emission
- o Sheath processes, non-linear expansion with potentials
- o Magnetic field constraints on particle trajectories
- o High electric field emission of electrons
- o Ultraviolet radiation effects photoemission
- o Ram and wake effects due to spacecraft velocity
- o Arc and corona breakdown (avalanche) effects

III. Benefits

High power high voltage missions of the future can not be enabled

Page 3 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2103 PAYLOAD ELEMENT SYNTHESIS

without knowledge of physical processes involving the interactions of the electrical power system and the natural and ion engine generated plasma environment. Protective design techniques will be analyzed, designed, implemented, tested and developed assuring a high reliability final design approach that will then be demonstrated.

IV. Justification

The Space Station facility is required for this mission because of: the large separation distances required between the ion source and the power system, the operation of large scale, high voltage, prototype solar arrays and, the high vacuum requirement.

V. Mission Requirements and Capabilities

- A) Operation in equatorial-like environments at altitudes of 300 to 400km with arbitrary inclination. (Space platform altitudes)
- B) Mass, Volume, Operational Envelope The mass has not been estimated as yet. The area of the array is about 150 square meters. It is proposed that this system function is sunlight for at least 6 months to complete the interaction evaluation. This includes the orbital eclipse shut-downs.
- C) Power Experiment will provide own power including power to the ion thruster.
- D) Thermal Control Self-contained thermal control subsystem.
- E) Attitude, Stabilization Power generator must be sunlit and held in nominal normal solar incidence on solar array. During normal operation, ion thruster shall be pointed opposite to the direction of travel.
- F) Viewing No shadowing of array by space structure allowed.
- G) Environmental Constraints The power system must operate in the undisturbed flow of natural space plasma and not in the wake of the space station. Operation during worst case of the natural plasma (solar activity, etc.) is desired.
- H) Data Management, Communications Output parameter of system will be monitored. All measurements involving high voltage will be conditioned to be compativle with existing command and data systems.
- Crew Timeline Not applicable
- J) Operations Schedule, Maintenance, Lifetime It is desired to turn on this sytems and leave on for a minimum of 6 months. Data will be collected and analyzed. Operational mode changes will be commanded in as appropriate to obtain desired information. (This could be done by automated sequences). There should be no maintenance required.

	•	TYPE
Large Solar Concentrator	6 D C D Z 1 U 4	
M. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division		Applications
Address P.O. Box 85357		
San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		X Tachnology
STATUS		148E(0)8/8/
nal		Operations
Approved Scandidate		
	78	NEW DOY
First flight, yr 1995		1202 12010 H)
Duration of Flight, days 365		Importance of the
OBJECTIVE To cevelop and deploy a large permanent mirror		this Element
facility to capture and concentrate AM-O solar radiation. To		
accurately establish optical characteristics of this facility	s facility	1 - low value but
	long-term	Could use
stability of the optical characteristics of the mirror.	ror.	ı
		Scale 1 - 10 9
DESCRIPTION		
The mission will provide the facility necessary for other Advanced Energetics missions.	other Advance	ed Energetics missions. It
will require development and deployment of a large stable concentrating reflector, and Will nowmit accomment of the ctability of 1) woflecting outical coatings and 2) morbanisms for	stable concent	crating reflector, and will ince and 2) mochanisms for
producing and holding optical quality reflector shapes in the space environment.	optical coate pes in the spa	ings, and 2/ mechanisms for

A Company of the second

CHARACTERISTI
Apogee, km <u>LEO</u> Perigee, km <u>LEO</u> Tolerance + Inclination, deg Any Nodal Angle, deg Escape dV Required, m/s
ENTATION on Inertial Solar
Pointing accuracy, arc sec < 900 Field of view, deg Pointing Stability (Jitter) arc sec/sec Special Restrictions (Avoidance) No shadowing of mirror by space structure allowed
OUER Gerating Operating Standby Gontinuous
Joltage, U Frequency, Hz
MMUNICATIONS Ing requirements: Realtime XOf Realtime XOf ryption/Decryption Requir Ink Req.:Command Rate (Ki Board Data Processing Req
Data Types! Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT)
Dump Frequer

ORIGINAL PAGE IS OF POOR QUALITY

CODE 6 D C D 2 1 0 4 Page 3 of 3	r
X W W W W W W W W W W W W W W W W W W W	3
Heat Rejection, w operational min max	
Remote Unpressurize	
1 1	
2000	
WIN H TROITS TOUR	
Crow Size 1 Task Assignment Assess Optical Characteristics	
I .I	
Hrs/Day 0.2	
EUA X VES UNO Reason Deploy/Optical Measurementy. JEUA 48	
SERUICING/MAINTENANCE	
SERVICE Interval, days Refurnables, kg	
nep	
les, kgReturns	
SPECIAL CONSIDERATIONS/Soc Instructions A significant effort will be required to deploy a large high-quality reflector 2-man EVA is is assumed for deployment. More effort will be	
needed to characterize its operation. Thus, it requires man in the set-up loop. Later it will require man to install, check out, operate, and repair advanced experiments. This facility re-	
quires a manned spacecraft with a mission life that is very long compared to the set-up and mapping times for the mirror. No Space Station power is required. No thermal control is required	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2104 ELEMENT NAME LAR	GE SOLAR CONCENTRATOR
ACCOMODATION: ATTACHED FREE FLY	ER 🔲 OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	ACHMENT AND CHECKOUT)
DATE(S) 1995 INT. HRS EVA	HRS 24 EVA CREW 2
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR N	IONITOR, INSPECT, ETC.)
HRS PER DAY (INTERNAL)	
0.6 HRS PER DAY (EVA)	
☑ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONFIGS.	
☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	•
DATE(S) INT. HRS EVA H	IRS EVA CREW
MOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	ABOVE)
 EVA required to set up reflector. EVA required for optical measurem Concentrator left in place for ne 	ents .06 hour per day for year=24 hour total

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2104

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Large Solar Concentrator

Reference Documents:

 Technology Development Missions, Space Station NAAO Orientaztion meeting, NASA Hq., 14-15 Sept 1982

Narrative:

Payload element objective description, and EVA reasons are from Ref 1.
All other data is derived.

Page 2 of 2 Volume II, Book 1 Appendix I

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Code: GDCD 2104

PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Advanced Energetics Research-I Langley Contact: E. J. Conway

Experiment Title: Deployment and Testing of Large Solar Concentrator

Mission Objectives: To develop and deploy a large permanent mirror facility to capture and concentrate AM-O solar radiation. To accurately establish the optical characteristics of this facility through systematic measurements, and to assess the long-term stability of the optical characteristics of the mirror.

<u>Mission Description</u>: The mission will provide the facility necessary for other Advanced Energetics missions. It will require development and deployment of a large stable concentrating reflector, and will permit assessment of the stability of 1) reflecting optical coatings, and 2) mechanisms for producing and holding optical quality reflector shapes in the space environment.

<u>Benefit</u>: This facility would be required for other experiments and would be a test item itself for optical coatings and shape.

<u>Justification</u>: Currently, space solar energy is only used as a power source with large flat plates of photovoltaic cells. Other conversion schemes for solar energy (such as solar-pumped lasers, solar-sustained plasmas and solar thermal engines) have been conceived, but most require solar concentration. This mirror would provide the well-characterized, high-quality concentrator in the AM-O environment necessary to properly develop and test advanced energy concepts.

<u>Mission Requirements and Capability</u>: The facility will require pointing and tracking to be useful. EVA will be required for deployment and intensity mapping.

Space Station vs. Free Flyer: A significant effort will be required to deploy a large high-quality reflector. More effort will be needed to characterize its operation. Thus, it requires man in the set-up loop. Later it will require man to install, checkout, operate, and repair advanced experiments. This facility requires a manned spacecraft with a mission life that is very long compared to the set-up and mapping time for the mirror.

	Page 1 of 3
NAME CODE 2 1 0 E	TYPE
Solar-Pumped Lasers	1 50 100 100
	Applications (non-commercial)
Audrass P.O. Box 85357 San Diego, CA 92138	O Commercial
Telephona (619) 277-8900, Ext. 3778/2130	X Technology Development
Opportunity	
r 1996	(see Table A)
270 days 270	Importance of the Space Station to
a. To demonstrate, calibrate and test the operation of a solar-	1 = low value but
l solar laser	Could use 10 - vital
types.	
	Scale 1 - 10
DESCRIPTION This mission will demonstrate for the first time solar-pumped lasing using the full solar spectrum (rather than a simulated spectrum). It will provide for the accurate measurement of solar laser efficiency which is spectrum and temperature-dependent and will provide for long-term operation to assess lasant stability and lasant reconstitution effi-	solar-pumped lasing using 11 provide for the accurate rature-dependent and will sant reconstitution effi-
ciency. The experiment will utilize the large solar concentrator deployed as payload GDCD 2104.	deployed as payload

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m			OF POOR (QUALITY,	
CODE 6.0.C.0.21.0.5 Page 2 of 3	Pariges, km LEO Tolerance + Any Tolerance + Ephemeris Accuracy, m	POINTING/ORIENTATION Use direction Inertial Solar IEarth Truth Sites (if known) Pointing accuracy, arc sec <900 Field of view, deg Pointing Stability (Jitter) arc sec/sec Special Restrictions (Avoidance) No shadowing of mirror by space structure allowed	JDC Power, U Duration, hrs/day	ATA/COMMUNICATIONS Onitoring requirements: Onone One One One Of One One One One One One One One One One	Data Types: Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

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6		,	, ,	, , , , , , , , , , , , , , , , , , , 			<u> </u>
0 5 Page 3 of		Stowed Deployed	Performance		18	. 6 10 10	curately repeat- of the laser in iators will require e human involve- e a manned space- duration, manned
CODE 6.0.0.2.1.0.5	X X & & & & & & & & & & & & & & & & & &	Ssurized H,m 10 H,m 200	Evaluate Las		urationHrs/EUA	s Man/Hrs Roq. Returnables.	CONS/See Instructions The mission will require accurately repeat-concentrator toward the sun and away from it. Placement of the laser in region of the concentrator and attachment to thermal radiators will require temperature measurements may also require human help. The human involvealling the laser and making measurements may also require a manned spaceation (on the order of weeks or months) requires a long-duration, manned station power is required. No thermal control is required. Weight for laser
	al ain al ain al ain	S Remote 1 rad Vnpre 10 ns filottu.	Task Assignment		Placement/ReconfigurationHrs/EUA	Consumables, Man Hours	·uctions The miss d the sun and away entrator and attach ements may also recond making measuremer of weeks or monthequired. No thermal
	Passive C operational non-operational operational non-operational non-operational	CHARACT Lon Lon Lon Consumat	2	B) SKILL LEVEL Hrs/Da	NO Reason	days days ss, kg GESIInt	TIONS/See Instructor towar region of the conctemperature measurtalling the laser a ration (on the order Station power is really to the order of the
	THERMAL Mactive Temperature, deg (Heat Rejection, w	EQUIPMENT PHYSICAL CHILOCATION Internal Equipment ID/Function L,m L,m L,m L,m Con Con	CREW REQUIREMENTS	Skills (Soo Tablo	EUA 🖾 YES	SERVICING/MAINTENANCE SERVICE: Interval, days Returnables, kg CONFIGURATION CHANGES: Interval,	able pointing of the concentrator toward the sun and away from it. Placement of the laser in the calibrated focal region of the concentrator and attachment to thermal radiators will require EVA. Laser power and temperature measurements may also require human help. The human involvement required in installing the laser and making measurements may also require a manned spacecraft. Long-term operation (on the order of weeks or months) requires a long-duration, manned spacecraft. No Space Station power is required. No thermal control is required. Weight for last

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GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GD	CD CODE 2105	ELEMENT NAM	E SOLAR	PUMPED L	ASFRS	
AC	COMODATION: 🗵 ATT	ACHED FR	EE FLYER	□ 0TV 0I	' S	
1.	STATION ACTIVATION (E.G	., SET-UP/ASSEM8	LY/ATTACHN	IENT AND CH	ECKOUT)	
	DATE(S) 1996 INT	r. HRS	EVA HRS	6	EVA CREW	2
					•	
	☐ NOT APPLICABLE					
2.	SERVICE (E.G., REPLINISH	(RESUPPLY)				
	INTERVAL DAYS	TOTAL SERVICE	:ES		:	
	TMS/OTV REQUIRED		ST	ATION HRS P	ER SERVICE	
	■ NOT APPLICABLE		EV	A HRS PER S	ERVICE	
			EV	A CREW SIZE		
3.	STATION OPERATIONAL S	UPPORT (AVG. TIM	E FOR MONI	TOR, INSPECT	, ETC.)	
	0.2 HRS PER DAY (NTERNAL)				
	HRS PER DAY (I	EVA)				
	☐ NOT APPLICABLE					
4	RECONFIGURATION					
••	INTERVAL 90 DAYS	TOTAL RECO	NFIGS. 2			
	TMS/OTV REQUIRED				R RECONFIC	G
	☐ NOT APPLICABLE		EV	A HRS PER RI	ECONFIG.	6
			EV	A CREW SIZE	_	2
_						
5.	DEACTIVATION/REMOVAL DATE(S)INT		5244 4100	,	CVA COCIN	
	UATE(S)INT	. нкъ	_ EAN HAS _		EVA CHEW _	
	NOT APPLICABLE				-	
_	_					
	NOTES (BRIEFLY DESCRIB			VE)		
1.		install lase toring of la	ers. Iser perf	ormance.		
3.						

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2105

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Solar-Pumped Lasers

Reference Documents:

 Technology Development Missions, Space Station NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982

Narrative:

The payload element objective, description, EVA reasons, and relation to earlier mission objectives are from Ref 1. The earlier mission is defined by GDCD 2104. Since this payload element uses laser elements of GDCD 2104, the schedule is sequenced.

All other data is derived.

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Code: GDCD 2105

PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Advanced Energetics Research - II Langley Contact: E. J. Conway

Experiment Title: Test Solar-Pumped Lasers

Mission Objectives: To demonstrate, calibrate, and test the operation of a solar-pumped laser using the AM-O solar spectrum and to use a large, high-quality optical concentrator deployed and characterized as an earlier mission objective. To provide a realistic comparison of several solar laser types.

Mission Description: The mission will demonstrate for the first time solar-pumped lasing using the full solar spectrum (rather than a simulated spectrum). It will provide for the accurate measurement of solar laser efficiency which is spectrum and temperature-dependent and will provide for long-term operation to assess lasant stability and lasant reconstitution efficiency.

Benefit: Solar-pumped lasers offer potentially revolutionary advances in space power and propulsion. This will be their first severe space test. Solar-pumped lasers offer low-maintenance, low-cost solar conversion. Long-term tests will assess the claim of low maintenence. Several lasants can be compared.

<u>Justification</u>: Lasers offer very important cost benefits for space propulsion and may be economical for space electric power, communications, and space processing. Trial and development of this technology is crucial to establishing its feasibility and reliability.

Mission Requirements and Capability: The mission will require accurately repeatable pointing of the concentrator toward the sun and away from it. Placement of the laser in the calibrated focal region of the concentrator and attachment to thermal radiators will require EVA. Laser power and temperature measurements may also require human help.

Space Station vs. Free Flyer: The human involvement required in installing the laser and making measurements and lasant changes requires a manned spacecraft. Long-term operation (on the order of weeks or months) requires a long-duration, manned spacecraft. Also, if the high-quality concentrator is on the space station, then the laser test must also be on the space station.

	Page 1 of 3
PAYLOAD ELEMENT NAME Laser/Electric Energy Conversion G D C D 2 1 0 6	TYPE
J. Peterson MZ 21-9530 Mamics Convair Division	Applications (non-commercial)
San Diego, CA 92138	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	X Technology Development
STATUS	
,	Tupe Number
First flight, yr 1996 No. of flights 1 Duration of Flight, days 450	
	Eloment
To characterize and compare for space operation the performance of laser-to-electric power converters, and to demonstrate short-range laser-power transmission in space.	1 = low value but could use 10 = vital
	Scale 1 - 10 4
DESCRIPTION	
Using a solar-pumped laser deployed and characterized as payload GDCD 2105 transmission over the longest spacecraft dimension will be performed and the intensity pattern at the converter site measured. An assessment of converter performance, efficiency, stability for longterm operation and resistance to environmental interference or degradation will be performed for a set of converters.	d GDCD 2105 transmission over nsity pattern at the conver- ciency, stability for long- degradation will be performed

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m)	OF	POOR QUALITY			
G D C D Z 1 O 6 Page 2 of 3	TERISTICS LEO Perigeo, km LEO Tolerance + deg Any Any Tolerance + deg Any Ephemeris Accuracy, m	Incrtial Solar Earth Incrtial Solar Earth Incrtial Solar Earth Solar Solar Earth Solar Solar Earth Solar Solar Earth Solar Solar Earth	oments: Realtime XOf cryption Requis command Rate (Ki Processing Req	pes: Analog Digital Hra/Day mount Olice (Hrs/Day) (Hrs/Day) Storage (MBIT)	Rate (KBP	
	ORBIT CHARACTERIST Apogeo, km LEO Inclination, deg Nodal Angle, deg Escape do Requires	OINT TEET TEET TOINT	OUER AC Operating Standby Peak	DATA/COMMUNICATION Monttoring requir None Encryption/De Uplink Req. 1 C	Data Types: Film (Amount Live TV (Hrs. On-Board Stor	rdi

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CODE G.D.C.D.2.1.0.6 Page 3 of 3
Temperature, deg C operational min max Heat Rejection, w operational min max non-operational min max non-operational min max
S il Remote izedXUnpressurize
Lym 10 W,m 10 H,m 10 Daployed Launch mass, kg 500 Daployed Consumables Tupes
Acceleratio
REQUIREMENTS 1 Task Assignment Evaluate Laser Power Transmission
Hrs/Day 0.2
NO Reason Setup Power/Reconfiguration 18 18
NGEStinterval, day Deliverables, kg.
lons
The major requirements will be periods of manned interaction, long-term constant power operation of the laser and recording of data for post-flight study. The program requires man tended operation and use of calibrated and operational facilities already developed and in place on the space station from earlier experiments. No Space Station power is required. No thermal control is required. Weight is for boiler, turbo machinery, alternator only.

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION Volume II, Book 1

Volume II, Book 1 Appendix I

GOCD CODE 2106 ELEMENT NAME L	ASER/ELECTRIC ENERGY C	<u>UNVERSIO</u> N
ACCOMODATION: 😡 ATTACHED 🔲 FREE FI	LYER OTV OPS	
I. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/AT	TTACHMENT AND CHECKOUT)	
DATE(S) 1996 INT. HRS EV	A HRS 6 EVA CREW_	2
	 -	
NOT APPLICABLE		
2. SERVICE (E.G., REPLENISH/RESUPPLY)		
INTERVAL DAYS TOTAL SERVICES _		
TMS/OTV REQUIRED	STATION HRS PER SERVICE	
☑ NOT APPLICABLE	EVA HRS PER SERVICE	
	EVA CREW SIZE	
3. STATION OPERATIONAL SUPPORT (AVG. TIME FO	R MONITOR, INSPECT, ETC.)	
0_2 HRS PER DAY (INTERNAL)		
HRS PER DAY (EVA)		
□ NOT APPLICABLE	•	
4. RECONFIGURATION		
INTERVAL 150 DAYS TOTAL RECONFIG	s 2	
TMS/OTV REQUIRED	STATION HRS PER RECONFIG	
☐ NOT APPLICABLE	EVA HRS PER RECONFIG	6
	EVA CREW SIZE _	2
5. DEACTIVATION/REMOVAL		
DATE(S) INT. HRS EV.	A HRS EVA CREW _	
■ NOT APPLICABLE		
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH	1 5 ABOVE)	
1. EVA required to install power c		rom 2105)
3. Control and monitoring of conve4. 2 trips required to changeout 1		
5. Most of apparatus required for		

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2106

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Laser Electrical Energy Conversion

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982

Narrative:

The payload element objective, description, use of developed facility/equipment and special considerations are from Ref 1. The earlier mission is defined by GDCD 2105. Since the payload element uses elements of GDCD 2105, the schedule is sequenced.

All other data is derived.

Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2106

PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Advanced Energetics Research - III Langley Contact: E. J. Conway

Experiment Title: Laser-to-Electric Energy Conversion

<u>Mission Objectives:</u> To characterize and compare for space operation the performance of laser-to-electric power converters, and to demonstrate short-range laser-power transmission in space.

Mission Description: Using a solar-pumped laser deployed and characterized under an earlier mission objective, transmission over the longest spacecraft dimension will be performed and the intensity pattern at the convertor site measured. An assessment of convertor performance, efficiency, stability for long-term operation and resistance to environmental interference or degradation will be performed for a set of convertors.

<u>Benefit</u>: By flight time, terrestrial R & D will have developed several useful laser-to-electric power conversion devices. Their efficiency, stability and reliability will require extensive space testing. Their environmental interaction and the maturity of the technologies will be assessed and improved as required.

Justification: The high cost and limited quantity of electric power in space has been identified as a limiting factor to expanding space activities. A change of function, from each spacecraft generating its own power to specialized central power stations producing and beaming power, could provide much more available power at reduced costs. R & D to assess these possibilities will require substantial space testing.

Mission Requirements and Capability: The major requirements will be periods of manned interaction, long-term constant power operation of the laser and recording of data for post-flight study.

<u>Space Station vs. Free Flyer</u>: This program requires man tended operation and use of calibrated and operational facilities already developed and in place on the space station from earlier experiments.

1		rage 1 of
PAYLOAD ELEMENT NAME	CODE	TYPE
Solar -Suscamed r Idsina		- Science &
CONTACT W. Hardy/J. Peterson MZ 21-9230 NAMO General Dynamics Convair Division		Applications (non-commercial)
San Diego, CA 92138		- Commercial
Telephone (619) 277-8900, Ext. 3778/2130		X Technology
STATUS		
Operational Operational	þ	Operations
X C	inte	11
Taruna John Comported Translation	far ren	Type Number
First flight, yr 1997		(see Table A)
Duration of Flight, days 450		Importance of the Space Station to
To demonstrate, contain, and characterize solar-sustained plasmas and to operate, and refine MHD electric power generation in space and plasma thruster performance.	era-	1 - low value but could use 10 - vital
		Scale 1 - 10 8
DESCRIPTION		
Concentrated sunlight will excite a plasma. Characteristics of the plasma and its containment system will be assessed in terms of theoretical performance and prior terrestrial tests. After suitable control and understanding have been achieved, the plasma will be used in MHD electri-	haracteristics of that performance and pachieved, the plasma	ht will excite a plasma. Characteristics of the plasma and its containment ssed in terms of theoretical performance and prior terrestrial tests. After d understanding have been achieved, the plasma will be used in MHD electri-
cal generating systems to identify their space reasibility and operating constraints. The plasma will also be assessed as the exhaust medium for thermal plasma thrusters and for MF thrusters. The mission will utilize the large solar concentrator deployed. Ref. payload GDCD 2104.	e reasibility and op edium for thermal pl solar concentrator	ims to ldentliy their space reasibility and operating constraints. The assessed as the exhaust medium for thermal plasma thrusters and for MPD ion will utilize the large solar concentrator deployed. Ref. payload

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GODE GOCDZIOZ Pege 2 of 3	Tolerance + Ephemeris Accuracy, m	⊠Solar □Earth Field of view, deg sec/sec	U Duration, hrs/day	line Other Frequency (MHZ)	□Digital □Hrs/Day Uoice (Hrs/Day) Uoice (Hrs/Day) Other bit) Downlink Frequency (MHZ)
	ORBIT CHARACTERISTICS Apoges, km LEO Periges, km Inclination, deg Any Nodal Angle, deg	OINTING/ORIENTATION Jaw direction Inertial ruth Sites (If known) ointing accuracy, arc sec < < 500 ointing Stability (Jitter) arc pacial Restrictions (Avoidance)	Dc Power,	UNICATIONS grequirements; Requirements; ption/Decryption Requir Req.:Command Rate (Ki ard Data Processing Reciption	Data Types: Analog Dig Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

ORICHMAL TA THE OF POOR QUALITY

C)		•					
7 Page 3 of		Stowed	Plasma Performance		30		Kg	or the plasmas temperature ion power is use of equipment.
CODE 6 0 C 0 2 1 0 7		10	Assess		ove Hrs/EUA	Nan/Hrs Roq.	Koturnablos,	Operation and testing of these devices will require diagnostic equipment both for the plasmas and for device operation, as well as the large solar concentrator and the high-temperature thermal radiator. Control by onboard scientists will be required. No Space Station power is required. Weight is for MHD generator, magnets only. Disassembly required. Last use of equipment.
	# T # 1	Remote X Chpressum 10 H,	يد ا	3	Reason Assembly/Reconfig/Remove Hrs/EUA	Consumbles, Am Hours	ctions	ll require diagnost large solar concent ntists will be requ gnets only. Disasse
	Passive operationa non-operationa operationa non-operationa non-operationa	CHARACTERISTICS Inal XExternal Ion Pressurize L,m 10 U,m L,m 10 U,m Launch mass, kg Consumables Types	1 - 1	B) SKILL LEVEL	ONO ReasonASS	2 H C	IONS/See Instructions	of these devices wi on, as well as the rol by onboard scie r MHD generator, ma
	Active ture, dag C jection, w	EQUIPMENT PHYSICAL Location Inter- Equipment ID/Funct	REQUIREMENTS Sizo	Skills (Soo Table B	X YES	SERVICING/MAINTENANCE SERVICE: Interval, day, Returnables, CONFIGURATION CHANGES	CONSIDERAT	Operation and testing and for device operation thermal radiator. Contirequired. Weight is for
	THERMAL [] Tompore Heat Ro	EQUI Equi	CREU	Sk1 l	EUA	SERU SERU CONF	SPECIAL	Oper and ther requ

GDC-ASP-83-002

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2107 ELEMENT NAI	ME SOLAR-SUSTAINED PLASMAS
ACCOMODATION: ATTACHED	REE FLYER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEM	BLY/ATTACHMENT AND CHECKOUT)
DATE(S) 1997 INT. HRS	EVA HRS 12 EVA CREW 2
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERV	ICES
TMS/OTV REQUIRED	STATION HRS PER SERVICE
NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AV 2. TI	ME FOR MONITOR, INSPECT, ETC.)
0.2 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
☐ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL 225 DAYS TOTAL REC	ONFIGS. 1
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☐ NOT APPLICABLE	EVA HRS PER AECONFIG6
•	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	•
DATE(S) 1998 INT. HRS.	EVA HRS EVA CREW
NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 TH	ROUGH 5 ABOVE)
1. EVA (2 days, 6 hrs each) re	equired to set up plasma device (uses 2104 concentrato
 Measurement and evaluation 1 reconfiguration (6 hr) to 	of performance
 Fecontiguration (6 nr) to Disassemble all exp. equipment 	o changeout thrusters Hent and prepare for earth return

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2107

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Solar-Sustained Plasmas

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982

Narrative:

The payload element objective, description, use of developed facility/equipment, special considerations, and skill level, are from Ref 1. The earlier mission is defined by GDCD 2104. Since the payload element uses elements of GDCD 2104 the schedule is sequenced.

All other data is derived.

Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2107

PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Advanced Energetics Research - V Langley Contact: E. J. Conway

Experiment Title: Solar-Sustained Plasmas

Mission Objectives: To demonstrate, contain, and characterize solar-sustained plasmas and to operate, assess, and refine MHD electric power generation in space and plasma thruster performance.

Mission Description: Concentrated sunlight will excite a plasma. Characteristics of the plasma and its containment system will be assessed in terms of theoretical performance and prior terrestrial tests. After suitable control and understanding have been achieved, the plasma will be used in MHD electrical generating systems to identify their space feasibility and operating constraints. The plasma will also be assessed as the exhaust medium for thermal plasma thrusters and for MPD thrusters.

<u>Benefit</u>: The direct use of solar radiation to produce plasmas will enable smaller, simpler space power and propulsion systems. Plasma devices which operate at high temperature require only small radiators to reject waste heat and thus offer important system and economic advantages for future applications.

<u>Justification</u>: Large amounts of free but low density energy exist in space in the form of sunlight. Capture, concentration to useful levels, and control of this energy is presently accomplished with photovoltaic cells and storage batteries. Optical concentration of sunlight and the production of high-temperature and ionized gases could provide an attractive option for the future, especially for néar-earth space processing requirements.

Mission Requirements and Capability: Operation and testing of these devices will require a large, high-quality solar concentrator (developed and put into operation during an earlier mission), a high-temperature thermal radiator, and diagnostic equipment both for the plasmas and for device operation. Control by on-board scientist will be required.

Space Station vs. Free Flyer: Space station will be required for this program since the research and testing require human interaction, long term operation, auxiliary equipment and electric power and a large high-quality mirror (which was developed under an earlier space station mission).

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1004
G 0 C 0 2 1 0 8
Applications (non-commercial)
□ Commercial
X Tachnology Development
Operations
Type Number 11
Importance of the Space Station to this Element
To evaluate the performance, reliability and life of a nuclear reactor of 100 kilowatts electrical power generating capability could use in the space environment.
Scale 1 - 10 9
ESCRIPTION A 100KW nuclear reactor (7% efficiency, $800 - 900^{\circ}$ C) will be deployed at the Space Station and connected to the station power distribution system. The Space Station power requirements will serve as the electrical load for the reactor which will be deisgned for long term operation in space. Source: Los Alamos National Labs. Joint DoD/DOE/NASA Project.

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C			POUR QUALITY		
CODE (G.D.C. D.2.1.0.8) Page 2 of 3	CHARACTERISTICS b, km LEO Perigee, km LEO Tolerance + nation, deg Any Any Tolerance + Angle, deg Ephemeris Accuracy, m e dV Required, m/s ING/ORIENTATION	View direction Inertial Solar Earth Truth Sites (if known) Field of view, deg Pointing Stability (Jitter)arc sec/sec Special Restrictions (Avoidance)	POUER Operating Standby Poak Voltage, U Frequency, Hz	DATA/COMMUNICATIONS Monitoring requirements: None X Realtime X Offline Other	Data Types: Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

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C	· · · · · · · · · · · · · · · · · · ·	N QUALITY	
Page 3 of	Stowed Deployed	mance Data	20
	4.5	Monitor Performance Data	ERVICING/MAINTENANCE ERVICING/MAINTENANCE ERVICEIInterval, days Returnables, kg ONFIGURATION CHANGES:Interval, day Deliverables, kg Nan/Hrs Req. Returnables, kg Deliverables, kg Returnables, kg No thermal control required. No Space Station power required. Reactor and radiator support boom approximately 90 meters long stowed, for Shuttle delivery, around circumference of 80 meter radiator. Radiation level at Space Station 1012 nvt neutrons, 106 rads gamma.
I MIN	Remote Toda Unpression 4.5 H. H. H. H. H. H. H. H. H. H. H. H. H.	esk Assignment 1 1 0.1	Consumables, Brval, day Iverables, kg Instructions Space Station power required. Ring stowed, for Shuttle delivery, at Space Station 10 ¹² nvt neutr
Passive operational operational operational non-operational	ARACT	1 1 6	SERVICEING/MAINTENANCE SERVICEIIntorval, days Returnables, kg CONFIGURATION CHANGES:Intorval, day Deliverables, kg SPECIAL CONSIDERATIONS/See Instructions No thermal control required. No Space Station postoom approximately 90 meters long stowed, for Shameter radiator. Radiation level at Space Station
1 42 2 1	EQUIPMENT PHYSICAL CHA Location: Dinternal Equipment ID/Function L,m L,m	CREU REQUIREMENTS Craw Siza Skills (See Table	SERVICEING/MAINTENALSERVICEIIntorval, SERVICEIIntorval, Roturnable CONFIGURATION CHAN SPECIAL CONSIDERAT No thermal control req boom approximately 90 meter radiator. Radiat

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2108 ELEMENT NAME	SPACE NUCLEAR REACTOR
ACCOMODATION: 🖸 ATTACHED 🗆 FRE	E FLYER* OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY	(/ATTACHMENT AND CHECKOUT)
DATE(S) 1997 INT. HRS	EVA HRS 20 EVA CREW 2
NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICE	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME	FOR MONITOR, INSPECT, ETC.)
0.1 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
☐ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECON	FIGS
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
⚠ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) INT. HRS	EVA HRS EVA CREW
☑ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROU	IGH 5 ABOVE)
*Free Flyer accommodation is an a	Iternate mode, and if used will

- 1. EVA required for deployment of reactor and boom, and for attachment to station. 2. Monitoring and evaluation of performance.
- 5. Reactor operation after year 2000.

require re-evaluation of all requirements.

Page 1 of 1 Volume II, Book 1 Appendix I

Code: GDCD 2108

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Space Nuclear Reactor

Reference Documents:

- 1. Los Alamos National Labs Briefing, Oct 1982
- 2. "Science" Vol 218, 17 Dec 1982 pp 1199-1201

Narrative:

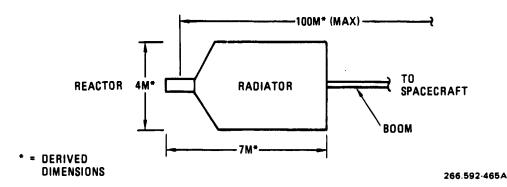
Ref 1 describes a nuclear thermoelectric power source for use in space. The unit is 10-100 KW with 100 KW as a design point (upper range of 200 KW). It uses heat pipes with no rotating machinery. The control rods (which rotate) are the only moving parts. It is intended for unmanned applications, but with appropriate spacing/shielding would be suitable for a manned station. The following are some technical parameters:

Technology is in development. A major advancement is required for the heat pipes in materials and for operating temperatures. LANL anticipates 8-9 years to deployment; NASA estimates 14-15 years. A Space Station would shorten development time by taking advantage of the long term presence in the space environment, for example, in heat tube technology.

Mission duration 7 years is from Ref 2, p 1200.

WEIGHT
POWER LEVEL
EFFICIENCY
TEMPERATURE
RADIATOR AREA
REACTOR
DEPLOYED DISTANCE
RADIATION (AT SPACECRAFT,
ASSUMING SOME SHIELDING)

20-30 KG/KW ELECTRICAL 100 KW 7% 800-900 DEG K 80 M² 55 CM DIA BY 55 CM LONG 25-100M 10¹² NVT NEUTRONS 10⁶ RADS GAMMA



Section _	3.3
Discipline	Computer Science & Electronics

GDCD ID NO.	PAYLOAD ELEMENT NAME
2201	Attitude Control - System Identification Experiment
2202	Attitude Control - Adaptive Control Experiment
2203	Attitude Control - Distributed Control Experiment
2204	Advanced Adaptive Control Technology Demonstration

		Page 1 of
PAYLOAD ELEMENT NAME Attitude Control, System Identification	CODE 6 D C D 2 2 0 1	TYPE
		Applications (non-commercial)
San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		X Tachnology
STATUS	poul	Operations
	Scandidate Dopportunity	Type Number 12
ght, yr 1994 Ights 1 of Flight, days		(see Table A) Importance of the Space Station to
OBJECTIVE		this Element
To validate sensing strategy/mechanization, identification algorithms and integrated flight control dynamics reconstruction subsystem; establishing off-line and real-time knowledge of flexible Space Station and payload dynamics.	identification algocs reconstruction	1 - low value but could use 10 - vital
		Scale 1 - 10
DESCRIPTION		
The experiment will consist of distributed excitation and sensing of structure and payloads. Sensor outputs will be recorded for off-line system identification or processed sequentially for on-board identification. A large structure will be constructed to facilitate characterizing dynamics and control parameters.	excitation and sensing he system identificatic ure will be constructe	consist of distributed excitation and sensing of structure and payloads. be recorded for off-line system identification or processed sequentially ication. A large structure will be constructed to facilitate characteriz- itrol parameters.

CODE G.D. 2.2.0.1 Page 2 of	ب 10
N Jinertial Solar	
Pointing accuracy, arc sec Field of view, deg Pointing Stability (Jitter)arc sec/sec Special Restrictions (Avoidance)	0 0 TTT
J AC	RIGINAL F POOR (
Standby 0 Continuous Peak 1000 Frequency, Hz	inki Qualn
UNICATIONS grequirements; \times \tim	Ϋ́ Ϋ́
Data Types: Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) Cive TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)	

n			ORIGII OF PO	NAL PAG OR QUA		I9 TY	7,
0 1 Page 3 of		Stowed	Structure Dynamics		20	24	Random crew motion & on-board environ. A data acquisition com GDCD 2005. Weight is for activities on the SS can be not req'ments. Thermal
CODE 6 D C D 2 2 0	X X X X X X X X X X X X X X X X X X X	irized m 100	naracterize	5 2 0.1	Remove Hrs/EUA	Man/Hrs Rog.	
	TITE TO THE PERSON OF THE PERS	Zed⊠Unpress M H H	Assignment	2 0.1 0	Rouson Assembly/Reconfig/ Re	Consume Man Hou	SPECIAL CONSIDERATIONS/See Instructions Exper requires a stable environ to assure accurate measurements we space Station. Low-g environ free from vibration perturbations. equip vibration must be minimized to achieve clean identification facil would be necessary to record & analyze data. Uses struct for sensors, controls, wiring only. If struct perturbations caused be minimized, the exper structure can be attached. No viewing/point control not req.
·	Passive operational non-operational operational	CHARACTERISTICS Inal External Lon Pressurize Lon 100 U,m Launch mass, kg Consumables Types	1 1	SKILL LEUEL Hrs/Day	NO ReasonAsse	- نه ه - نه ه - نه - نه	Exper requires a stable environ to assure accurate Space Station. Low-g environ free from vibration equip vibration must be minimized to achieve clean facil would be necessary to record & analyze data. sensors, controls, wiring only. If struct perturb minimized, the exper structure can be attached. No control not req.
	deg C	PHYSICAL Intern ID/Functi	EMENTS 2	(See Table B)	☑ YES □	NTENANC Val, da Nablos, CHANGE	Exper requires a stable en Space Station. Low-g envequip vibration must be m facil would be necessary sensors, controls, wiring minimized, the exper structural not req.
	THERMAL	EQUIPMENT Location: Equipment	CREU RE Craw SI	Skills (Soo	EUA 🖾	SERVICING/MAI SERVICE: Inter- Retur CONFIGURATION	SPECIAL CONSI Exper requires a Space Station. equip vibration facil would be n sensors, control minimized, the e control not req.

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2201 ELEMENT NAME ATT	CNTRL-SYSTEM IDENT EXPERMT
ACCOMODATION:	
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	ACHMENT AND CHECKOUT)
DATE(S) 1994 INT. HRS 6 EVA	HRS 6 EVA CREW 1
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR N	IONITOR, INSPECT, ETC.)
0.2 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	• .
☐ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL 90 DAYS TOTAL RECONFIGS.	
TMS/OTV REQUIRED	STATION HRS PER RECONFIG. 4
☐ NOT APPLICABLE	EVA HRS PER RECONFIG. 4
	EVA CREW SIZE1
5. DEACTIVATION/REMOVAL	•
DATE(S) 1995 INT. HRS. 2 EVA H	IRS 2 FVACREW 1
□ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	ABOVE)
 Reconfig struct from GDCD 2005 fo Characterize structural dynamics Remove experiment peculiar equipm 	for multiple variations

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2201

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Attitude Control - System Identification Experiment

Reference Document:

1. Technology Development Missions, Space Stations NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982

Narrative:

The payload element objective, description, special considerations, power and skill level are from Ref 1. Control of crew perturbations is assumed for the attached mode.

All other data is derived. This payload element uses the structure provided by GCDC 2005 Dynamics of Flimsy Structures.

Code: GDCD 2201

PAYLOAD ELEMENT SYNTHESIS

ATTITUDE CONTROL - SYSTEM IDENTIFICATION EXPERIMENT

I. <u>Mission Objectives</u>

To validate sensing strategy/mechanization, identification algorithms and integrated flight control dynamics reconstruction subsystem; establishing off-line and real-time knowledge of flexible Space Station and payload dynamics.

II. Mission Description

The experiment will consist of distributed excitation and sensing of structure and payloads. Sensor outputs will be recorded for off-line system identification or processed sequentially for on-board identification.

III. Benefit

These experiments will establish in-flight control performance of large flexible structures. In addition, they will determine vehicle intertia/ CG and mode shapes and frequencies which will assist future design concepts.

IV. Justification

Accurate control of large flexible structures requires a knowledge of the dynamic characteristics. These experiments are necessary to establish these charactistics which lead to advance control system concepts for the large structures.

V. <u>Mission Requirements & Capabilities</u>

- A) Orbital Parameters High enough altitude to prevent drag effects on structure.
- B) Mass, volume, operational envelope Transporation of large number of elements (TBD) to construct an adequately sized structure to characterize large structure dynamics and control.
- C) Power The power requirements would be on the order of a kilowatt for the excitation and data acquisition systems.
- D) Thermal Control no requirement
- E) Attitude, Stabilization The experiments must be done in a stable environment to assure accurate measurements which would not be affected by Space Station.
- F) Viewing No requirements
- G) Environmental Constraints low g environment from vibration perturbations.

Page 3 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2201

PAYLOAD ELEMENT SYNTHESIS

- H) Data Management, Communications A data acquisition facility would be necessary to record and analyze the data. Communications would be by hard wire link if attached to the Station or RF transmission to the Space Station if on a free flyer.
- I) Crew Timeline Random crew motion and on-board equipment vibration must be minimized to achieve clean identification environment. Payload specialists would be needed for assembly and configuration changes.
- J) Operations Schedule, Maintenance, Lifetime-TBD

VI. Space Station vs. Free Flyer

If the structural perturbations caused by activities on the Space Station can be minimized, then the experimental structure can be attached. Otherwise, a tethered or free flyer configuration must be used.



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		Page 1 of 3
PAYLOAD ELEMENT NAME Attitude Control, Adaptive Control	CODE G D C D 2 2 0 2	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Name General Dynamics Convair Division		Applications (non-commercial)
San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		X Technology Development
STATUS	od.	□ Operations
	Candidate Opportunity	Type Number 12
First flight, yr 1994 No. of flights 1 Duration of Flight, days 365		(see Table A) Importance of the Space Station to
OBJECTIVE		this Elomont
To validate performance and stability improvement strategies and mechanization, control gain update and reconfiguration schemes, and adaptive control	ement sensing opdate subroutines ontrol algorithms.	1 - low value but could use 10 - vital
		Scale 1 - 10
DESCRIPTION		
This experiment will evaluate adaptive control algorithms and measurement heirarchy for an evolving or deploying structure. It will include articulation and reconfiguration of paylog to change system mass properties and evaluate adaptive control design. The structure could the same one deployed as payload GDCD 2201, and sequenced after 2201.	ol algorithms and meadling and meadling articulation and and adaptive control do and sequenced after 3	svaluate adaptive control algorithms and measurement heirarchy for an structure. It will include articulation and reconfiguration of payloads properties and evaluate adaptive control design. The structure could be as payload GDCD 2201, and sequenced after 2201.

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6 0 C 0 2 2 0 2 6 3	* * * *	□ Earth	view, deg	Duration, hrs/day		Frequency (MHZ)]Hrs/Day (Hrs/Day) Other	Downlink Frequency (MHZ)
	NISTICS Perigee, km LEO 9 Any 19 Any 19 Any	ION Solar Solar	ب ب	rating 1000 Power, U	Peak 1000 Frequency, Hz	MUNICATIONS ng requirements! XRealtime XOf yption/Decryption Requir nk Req.: Command Rate (Ki oard Data Processing Req	L) Chalog Digital (S/Day)	a Dump Frequency (Per Orbit) ording Rate (KBPS) 1.0

ORIGINAL PAGE DE OF POOR QUALITY

of 3				JOR Q	UALIT	Y	T	
2 Page 3		Stowed Deployed	ol Approaches		10	. 8	kg	lich would not be affected by Random crew motion & on-board environ. A data acquisition com GDCD 2005. Weight is for activities on the SS can being req'ments. Thermal
CODE G.D. C.D.2.2.0	X X X A A A A A A A A A A A A A A A A A	N M M M M M M M M M M M M M M M M M M M	Evaluate Control		Hrs/EUA	kg Man/Hrs Rog.	Returnables	neasurements which would not be affected by srturbations. Random crew motion & on-boar identification environ. A data acquisition Uses struct from GDCD 2005. Weight is for ions caused by activities on the SS can be viewing/pointing req'ments. Thermal
Ö		Lya 100		1 2	Assembly/Reconfiguration Hrs/EUA	Consummbles, Man Hours		~ ~ ~
	onal min onal min onal min	ornal Remotessurized Numbre U, m L, m	1		-5 1		bles, kg	sure accurate om vibration p achieve clean analyze data. truct perturba attached. No
·	Passive operational non-operational operational non-operational non-operational	L CHACTERISTICS brna! External tion Pressuri L,m 100 U, L,m 100 U, Launc! mass, kg Consumables Type	2	SKILL	Hrs/Day	نډ ع	TIONS/See Instructions	le environ to assure accurate environ free from vibration p be minimized to achieve clean ary to record & analyze data. ring only. If struct perturbastructure can be attached. No
	dag C	PHYSICA Intellible	IREMENTS	See Table B		interval, daturnables	ONSIDERATI	Exper requires a stable Space Station. Low-g er equip vibration must be facil would be necessary sensors, controls, wirir minimized, the exper strontrol not req.
	THERMAL Temperature, Heat Rejectives	EQUIPMENT Location: Equipment	CREU REOU		EUA XYES	SERVICING/MAINTEN SERVICE: Interval, Returnabl	SPECIAL CONSIDERA	Exper requires a state Space Station. Low-quip vibration must facil would be necess sensors, controls, we minimized, the experticontrol not req.

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2202 ELEMENT NAME	ATT CNTRL-ADAPTIVE CNTL EXPERIMENT
ACCOMODATION: 🗵 ATTACHED 🗆 FRE	E FLYER
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY	Y/ATTACHMENT AND CHECKOUT)
DATE(S) 1994 INT. HRS 4	EVA HRS 4 EVA CREW 1
	
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICE	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
□ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME	FOR MONITOR, INSPECT, ETC.)
0.2 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
☐ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL 180 DAYS TOTAL RECON	FIGS1
TMS/OTV REQUIRED	STATION HRS PER RECONFIG. 4
☐ NOT APPLICABLE	EVA HRS PER RECONFIG4
	EVA CREW SIZE1
5. DEACTIVATION/REMOVAL	
	EVA HRS 2 EVA CREW 1
DATE(S)	EVA ONEW
□ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROL	IGH 5 AROVEL
this experiment.	0-2005, previously used in GDCD 2201, for
 Evaluate control approaches f Remove experiment peculiar ed 	for multiple conditions quipment not needed later

TOTAL EVA HRS 10

THE R. P. LEWIS D. LEWIS CO. LANSING MICH.

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2202

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Attitude Control - Adaptive Control Experiment

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq., 14-15 September 1982.

Narrative:

The payload element objective, description, special considerations, power and skill level are from Ref 1. Control of crew perturbations is assumed for the attached mode.

All other data is derived. This payload element is assumed to be able to use the structure provided by earlier experiments (Identified as GDCD 2005 & 2001). Therefore, the schedule is sequenced.

Page 2 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2202 PAYLOAD ELEMENT SYNTHESIS

ATTITUDE CONTROL - ADAPTIVE CONTROL EXPERIMENT

I. Mission Objectives

To validate performance and stability improvement sensing strategies and mechanization, control gain update subroutines and reconfiguration schemes, and adaptive control algorithms.

II. Mission Description

This experiment will evaluate adaptive control algorithms and measurement hierarchy for an evolving or deploying structure. It will include articulation and reconfiguration of payloads to change system mass properties and evaluate adaptive control designs.

III. Benefit

It is expected that new concepts in attitude control of large space structures will require the development of new algorithms as well as new measures of performance evaluation which will be developed during these experiments.

IV. Justification

Control of large space structures requires the understanding of new control algorithms, in parallel, with the development of various structural configurations. The Space Station provides a unique facility to develop these control schemes in an unlimited dimensional environment with zero gravity.

V. Mission Requirements and Capabilities

- A) Orbital Parameters High enough altitude to prevent drag effects on structure.
- B) Mass, volume, operational envelope Existence of a large structure as an appendage to the Space Station or as a free flying (or tethered) vehicle near the station.
- C) Power The power requirements would be on the order of a kilowatt for the excitation and data acquisition systems.
- D) Thermal Control no requirement
- E) Attitude, Stabilization The experiments must be done in an environment which is structually isolated from the Space Station to assure that the data is not affected by Station perturbations.

Code: GDCD 2202

PAYLOAD ELEMENT SYNTHESIS

- F) Viewing no requirements
- G) Environmental Constraints Experiments require a low g environment with minimum vibrational perturbations from the Space Station.
- H) Data Management, Communications A data acquisition and analysis system would be necessary to record the data and develop control schemes in near real time.
- I) Crew Timeline Random crew motion and on-board equipment vibration must be minimized to achieve clean identification environment. In addition, the paylaod specialists must be able to reconfigure the structure to test the algorithm sensitivities to changes in the structural configuration.
- J) Operations Schedule, Maintenance, Lifetime TBD

VI. Space Station vs. Free Flyer

If the structural perturbations caused by activities on the Space Station can be minimized, then the experimental structure can be attached. Otherwise, a tethered or free flyer configuration must be used.

ORIGINAL PAGE IN OF POOR QUALITY

	E TO I ODEL
PAYLOAD ELEMENT NAME Attitude Control, Distribution Control G D C D 2 2 0 3	TYPE
terson MZ 21-9530 cs Convair Division	
San Diego, CA 92138	- Commercial
Telephona (619) 277-8900, Ext. 3778/2130	X Technology Development
Operational Planned Approved	Operations
U Opportunity	Tupe Number (See Table A)
No. of flights 1 365 Duration of Flight, days	Importance of the Space Station to
OBJECTIVE	this Eloment
To validate hardware, algorithms and systems for active vibration damping, cooperative payload pointing, modular control, control during deployment, and precision pointing/stabilization.	ion. 10 = vital
	Scale 1 - 10 9
DESCRIPTION The experiment consists of multipoint payload vibration/shape sensing with a sensor attached to the Space Station. Distributed actuation along the experimental structure will allow optimal placement of actuators and control schemes. Articulation and deployment of payloads will assist in further understanding of control variations as the structural configuration changes. A controlled coupling would exist at the interface between the structure and the Space Station. The structure could be the same one as deployed as payload GDCD 2201, and sequenced after 2202.	vibration/shape sensing with a along the experimental structures. Articulation and deployment of iations as the structural configurations as the structure and ployed as payload GDCD 2231, and

ORIGINAL PAGE IS OF POOR QUALITY

e			OF POOR QU	ALITY,	
2 2 0 3 Page 2 of			Continuous	Frequency (MHZ)	(MHZ)
CHARACTERISTICS b, km LEO Periges, km LEO Tolera	Required,m/s ORIENTATION Ction Inertial Solar	41 43	1000 Power,	Voltage, U DATA/COMMUNICATIONS Monitoring requirements: None None Encryption/Decryption Required Uplink Req.: Command Rate (KBS) On-Board Data Processing Required Description	Data Types! Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

ORIGINAL PAGE 19 OF POOR QUALITY

6		OF POOR	QCALI, I	
GDCD2203 Page 3 of	X 0 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	Stowed Stowed H,m 100 Deployed	2 Task Assignment Evaluate Control Approach B) SKILL 1 5 Hrs/Day 0.1 0.1 NCE days NCE Task Assignment Evaluate Control Approach Hrs/Day 0.1 0.1 NCE days Sirve Consumables, kg Deliverables, kg Deliverables, kg Returnables, kg Deliverables, kg Returnables, kg Deliverables, kg Returnables, kg Returnables, kg Deliverables, kg Returnables, kg Returnables, kg Returnables, kg Deliverables, kg Returnables, kg Returnables, kg Returnables, kg Deliverables, kg Returnables, kg Returnables, kg Returnables, kg Returnables, kg Deliverables, kg Returnables, kg Deliverables, kg Returnables, kg Returnables, kg Returnables, kg Returnables, kg Returnables, kg Bettered by Returnables, kg Returnables, kg Returnables, kg Returnables, kg Bettered by Returnables, kg Return	sensors, concrois, wiring only. It struct perturbations caused by activities on the SS can be minimized, the exper structure can be attached. No viewing/pointing requments. Thermal control not req.
·	1	zed Vnpres	Task Assignment B) SKILL LEVEL Reuson Configuration Changes NCE days S, kg Deliverables, kg Ren Hours IONS/See Instructions e environ to assure accurate measurements we environ to assure accurate measurements we not not present in the configuration of	ict perturbations tached. No view
·	Passive operational operational operational operational non-operational	ARACT	B) SKILL LEUEL Hrs/Day NCE days bs, kg TGES:Interval, day Deliverables, kg environ to assure accurate environ free from vibration be minimized to achieve clears, to record & analyze data	ing unig. In struct pertu tructure can be attached.
	THERMAL —Active Temperature, deg C Heat Rejection, w	EQUIPMENT PHYSICAL CH Location: Internal Equipment ID/Function L,n L,n	CREU REQUIREMENTS Crew Size Skills (See Table B) Skills (See Table B) EVEL Hrs/Day EVA X YES CONFIGURATION CHANGE SERVICE Interval, day CONFIGURATION CHANGES Interval, day Deliverables, kg Exper requires a stable environ to assure accurate Space Station. Low-g environ free from vibration equip vibration must be minimized to achieve clean facil would be necessary to record & analyze data.	minimized, the exper str control not req.

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2203 ELEMENT	NAME ATT CNTL-DISTRIBUTED CNTL EXP.
ACCOMODATION: 😡 ATTACHED (☐ FREE FLYER ☐ OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASS	EMBLY/ATTACHMENT AND CHECKOUT)
DATE(S) 1995 INT. HRS 4	EVA HRS 4 EVA CREW 1
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SE	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG	. TIME FOR MONITOR, INSPECT, ETC.)
0.2 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
☐ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL 180 DAYS TOTAL	RECONFIGS ±
TMS/OTV REQUIRED	STATION HRS PER RECONFIG. 4
☐ NOT APPLICABLE	EVA HRS PER RECONFIG. 4
	EVA CREW SIZE1
5. DEACTIVATION/REMOVAL	·
DATE(S) 1996 INT. HRS	2 EVA HRS 2 EVA CREW 1
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1	THROUGH 5 ABOVE)
	GDCD 2005, previously used in GDCD 2202,
for this experiment 3. Evaluate control approach	nes
	ar equipment not needed later

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Code: GDCD 2203

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Attitude Control - Distributed Control Experiment

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq., 14-15 September 1982.

Narrative:

The payload element objective, description, special considerations, power, and skill level are from Ref 1. The station-attached mode is required.

All other data is derived. This payload element is assumed to be able to use the structure provided by earlier experiments (Identified as GDCD 2005 & 2202). Therefore, the schedule is sequenced.

Page 2 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2203

PAYLOAD ELEMENT SYNTHESIS

ATTITUDE CONTROL DISTRIBUTED CONTROL EXPERIMENT

I. Mission Objectives

To validate hardware, algorithms and systems for active vibration damping, cooperative payload pointing, modular control, control during deployment, and precision pointing/stabilization.

II. Mission Description

The experiment consists of multi-point payload vibration/shape sensing with a sensor attached to Space Station. Distributed actuation along the experimental structure will allow optimal placement of actuators and control schemes. Articulation and deployment of payloads will assist in further understanding of control variations as the structural configuration changes. A controlled coupling would exist at the interface between the structure and the Space Station.

III. Benefit

This experiment will be the final proof test of control techniques for various configurations of large space structures taking advantage of the control algorithms and concepts developed during the "adaptive control experiments."

IV. Justification

These experiments will validate the accuracy and precision of pointing and control of large space structures.

V. Mission Requirements and Capabilities

- A) Orbital Parameters High enough altitude to prevent drag effects on structure.
- B) Mass, volume, operational envelope Existence of a large structure as an appendage to the Space Station.
- C) Power The power requirements would be on the order of a kilowatt for the excitation and data acquisition systems.
- D) Thermal Control no requirement
- E) Attitude, Stabilization The experiments must be done in an environment which is as structually isolated from the Space Station as possible while being attached through a sensor.

Page 3 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2203

PAYLOAD ELEMENT SYNTHESIS

- F) Viewing no requirements
- G) Environmental Constraints Experiments require a low g environment with minimum vibrational perturbations from the Space Station.
- H) Data Management, Communications A data acquisition and analysis system would be necessary to record the data and develop control schemes in near real time.
- I) Crew Timeline Random crew motion and on-board equipment vibration must be minimized to achieve clean identification environment. In addition, the paylaod specialists must be able to reconfigure the structure to test the algorithm sensitivities to changes in the structural configuration.
- J) Operations Schedule, Maintenance, Lifetime TBD

VI. Space Station vs. Free Flyer

Not applicable

		Page 1 of
PAYLOAD ELEMENT NAME Advanced Adaptive Control	CODE TYPE	
erson MZ 21-9530 s Convair Division	ว ส	Applications (non-commercial)
San Diego, CA 92138	0	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	 X	X Technology Development
Operational Planned	0	Operations
Unpproved Candidate Copportunity	Туре	
First flight, yr 1996 No. of flights 1 Duration of Flight, days 365	Import	(see Table A) Importance of the Space Station to
OBJECTIVE Evaluate adaptive control techniques required by advanced space station configurations. These adaptive control techniques will include closed-loop systems identification.		
	9 7	could use
	Scal	Scale 1 - 10 8
DESCRIPTION Advanced adaptive control laws will be provided as selectable alternatives to operational	oloctable altowns	tives to constitute
control laws. Various advanced techniques will be evaluated with the operational system serving as a backup. The structure could be the same one deployed as payload GDCD 2201, and sequenced after 2203.	aluated with the cone deployed as p	operational system payload GDCD 2201,

m		} }-	r		; []]]]
2.0.4 Page 2 of			□ Continuous	(MHZ)	(2)
CODE G.D.C.D.2.2.0.4	Perigee, km LEO Tolerance + Any Tolerance + Ephemeris Accuracy, m	Inertial Solar Searth Inc secField of view, deg (Jitter)arc sec/sec	Power, W Duration, hrs/day 00 00 Frequency, Hz	⊠ Sof Requis	Analog Digital Hrs/Day Voice (Hrs/Day) Other Other Cauchy (MBIT) Downlink Frequency (MHZ)
	Apogee, km LEO Peri Inclination, deg Any Nodal Angle, deg	OINTING/ORIENTATION 19w direction II ruth Sites (1f known ointing accuracy, arc ointing Stability (OUER MAC Doperating 10 Standby 10 oltage, U	MUNICATION IN require Eption/Decord oard Data ription	Data Types! An Film (Amount) Live TU (Hrs/Day) On-Board Storage (Data Dump Frequenc

Ö	G D C D 2 2 0 4 Page 3 of 3
THERMAL [] Active	
EQUIPMENT PHYSICAL CHARACTERISTICS Location: Internal External Remote Equipment ID/Function Pressurized Unpressurized L,m 100 U,m H,m L,m U,m U,m L,m U,m Consumables Types Consumables Types	Stowed
Task Assignment	Evaluate Control Approach
- F	Hrs/EUA 10
UICING/MAINTENANCE UICE:Interval, days Returnables, kg FIGURATION CHANGES:Interval, days	1 1 1
les, kg	bles, kg
lons curate measurements vation perturbations. clean identification data. Uses struct ferturbations caused teled. No viewing/point	neasurements which would not be affected by srturbations. Random crew motion & on-board dentification environ. A data acquisition Uses struct from GDCD 2005. Weight is for ions caused by activities on the SS can be viewing/pointing req'ments. Thermal

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

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GDCD CODE 2204 ELEMENT NAME A	DV ADAPTIVE CNTL TECHNOLOGY DEMO
ACCOMODATION: ATTACHED FREE	
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/A	TTACHMENT AND CHECKOUT)
DATE(S) 1996 INT. HRS 4 E	VA HRS 4 EVA CREW 1
	·
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FO	R MONITOR, INSPECT, ETC.)
0.2 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
☐ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL 180 DAYS TOTAL RECONFIG	ss1
☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIG. 4
☐ NOT APPLICABLE	EVA HRS PER RECONFIG4
	EVA CREW SIZE1
5. DEACTIVATION/REMOVAL	
DATE(S) 1997 INT. HRS. 2 EV	A HRS 2 EVA CREW !
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUG)	1 5 ABOVE)
	2005, previously used in GDCC 2202
for this demo mission.	previously used in duct 2202
 Evaluate control approaches Remove experiment equipment not 	needed later

TOTAL EVA HRS ______10

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2204

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Advanced Adaptive Control - Technology Demonstration

Reference Documents:

 Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq., 14-15 September 1982.

Narrative:

The payload element objective, description, special considerations, and skill level are from Ref 1. Station-attached operation is required.

All other data is derived. This payload element is assumed to be able to use the structure provided by earlier experiments (Identified as GDCD 2005 & 2203). Therefore, the schedule is sequenced.

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Code: GDCD 2204

PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title:

Langley Contact:

Spacecraft Control Technology Development

L. W. Taylor, Jr.

Experiment Title:

Advanced Adaptive Control Technology Demonstration

Mission Objectives:

Evaluate adaptive control techniques required by advanced space station configurations. These adaptive control techniques will include closed-loop systems identification.

Mission Description:

Advanced adaptive control laws will be provided as selectable alternatives to operational control laws. Various advanced techniques will be evaluated with the operational system serving as a backup.

Benefit:

Systems identification and adaptive control technology must continue to evolve as space stations become more complex and flexible. Advanced techniques must be validated prior to operational use.

Justification:

Technology supports space station evolution and therefore requires realistic large flexible structures as a test bed. Ground testing of this technology is not possible.

Mission Requirements and Capability:

Essentially the same as the operational control system. Expanded or modified computational capability is anticipated.

Space Station vs. Free Flyer:

Technology applies to multibody, flexible space stations as opposed to single body, relatively stiff free flyers.

we a stand of a rest to

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Appendix I

Section _ Discipline	3.4 Propulsion	1
GDCD ID NO.	PAYLOAD ELEMENT NAME	
2301 2302	Controlled Acceleration Propulsion Technology Laser Propulsion Test	

		Page 1 of
PAYLOAD ELEMENT NAME Controlled Accel Propulsion Tech	CODE G D C D 2 3 0 1	•
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division		Applications (non-commercial)
San Diego, CA 92138		- Commercial
Telephone (619) 277-8900, Ext. 3778/2130		X Technology Development
STATUS Operational	nod.	Operations
	Opportunity	Number
First flight, yr 1994 No. of flights 1 Duration of Flight, days 180		Importance of the Space Station to
OBJECTIVE Determine the reasibility, characteristic, straints, and interfaces of propulsion systems required controlled acceleration of space systems and correlate t ground and space characteristics of candidate concepts.	con- for he	this Element 1 = low value but could use 10 = vital
		Scale 1 - 10 9
DESCRIPTION Candidate low thrust propulsion concepts will be attached to the Space Station or associated space system if program objectives so indicate. The propulsion system will be operated to determine the feasibility of and constraints on their use to control accelerations induced by natural and space system forces and torques. Associated diagnostics will assess plume characteristics which cannot be adequately evaluated in ground tests. The performance and lifetime will be evaluated by the use of flight and post flight inspections to correlate space and ground results. The specific propulsion concepts to be evaluated will include resistojets operated (1) in several modes which affect their dynamic thrust characteristics and (2) with various propellants.	ion concepts will be a tives so indicate. If d constraints on their and torques. Associate ately evaluated in gra of flight and post flight affect their dynamic a	idate low thrust propulsion concepts will be attached to the Space Station system if program objectives so indicate. The propulsion system will be ne the feasibility of and constraints on their use to control accelerations and space system forces and torques. Associated diagnostics will assess as which cannot be adequately evaluated in ground tests. The performance evaluated by the use of flight and post flight inspections to correlate sults. The specific propulsion concepts to be evaluated will include resisin several modes which affect their dynamic thrust characteristics and (2) lants.

ORBIT CHARACTERISTICS	a, ka LEO nation, deg Angle, deg e do Require	POINTING/ORIENTATION Usew direction Inertial Solar Earth Truth Sites (if known) Pointing accuracy, arc sec Field of view, deg Pointing Stability (Jitter) arc sec/sec	OUER Operating Standby Peak	A/COMMUNICATIONS Itoring requirements! None	Data Types: Analog Digital Hre/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)
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ORIGINAL PAGE IS

•		OF PO	OR Q	UALI	, ,				
3.0.1 page 3.56		Stowed Deployed			01	. 50	Roq.	uires controlled	
CODE 6 D C D 2 3 0 1	X X X X 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	0.4 et Fuel			411	kg,	in the	ommodation rec	
	#1.n #1.n #1.n	External Remote Pressurized Pressurized W.m 0.4 H.m 0.		7 2	Hrs/Day 0.2	Consumables,	ka Hours	Lions Assumed attached accommodation requires controlled	
	ational m tional m tional m		Task	SKILL LEVEL	Hrs/Day	90	day los.	IONS/See Instructions igenic propellants. Assumed	
	υ 3 6	PHYSICAL CHARA(Internal ID/Function L,m L,m L,m Consum Accele	REQUIREMENTS 1	Table B)	2	AINTENANCE orval, days	X ••	SIDERATIONS/	
		EQUIPMENT P Location: Equipment I	CREW REQUIR	Skills (See Table	EUA KIVES	SERVICING/MAINTENANCE SERVICE Interval, day	CONFIGURATI	SPECIAL CONSIDERAT Assumed to use noncryo station acceleration d	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

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G	OCD CODE	23	01	ELEM	ENT NAME	CONTROL	LED A	CCELERATIO	N PROPULSION	TECHNOLOGY
Αſ	CCOMODA	TION:	X ATTA	CHED	☐ FRE	E FLYER	— 01	V OPS		
1.	STATION	ACTIVAT	rion (E.G.,	SET-UP	/ASSEMBL	Y/ATTACHN	ENT AN	CHECKOUT)		
	DATE(S)	1994	INT.	HRS	4	_ EVA HRS	4	EVA CRE	v <u>1</u>	
	□ NO	T APPLICA	ABLE	_	<u> </u>	-				
2.	SERVICE	(E.G., RE	PLENISH/I	RESUPPL	_Y)					
	INTERVA	AL 90	DAYS	TOTA	L SERVICE	ES1				
	☐ TM	S/OTV RE	QUIRED_			ST	ATION H	RS PER SERVIC	E2	
			ABLE _					ER SERVICE	2	
						E/	A CREW	SIZE	1	
3.	STATION	OPERAT	IONAL SU	PPORT (AVG. TIME	FOR MONI	TOR, INS	PECT, ETC.)	-	
	0.	2_ HRS PE	R DAY (IN	ITERNA	L)					
		 HRS PE	R DAY (E	VA)						
	□ NO	T APPLIC	ABLE							
4.	RECONF	IGURATIO)N							
	INTERV	\L	DAYS	TOT	AL RECON	IFIGS				
	☐ TM:	S/OTV RE	QUIRED			ST.	ATION HI	RS PER RECONF	ig	
	⊠ NO	T APPLICA	ABLE			EV	A HRS PE	R RECONFIG.		
						EV	A CREW	SIZE		
5.	DEACTIV	/ATION/R	EMOVAL							
	DATE(S)	1994	INT.	H RS		EVA HRS	4	EVA CREW	1	
	□ NO	T APPLIC	ABLE	_		-		_		
6.	NOTES (BRIEFLY	DESCRIBE	TASKS	IN 1 THRO	UGH 5 ABO	VE)			
3	Rep 2-8 col1	lenish hour m lect da	propel uns pe ita.	lant r 90 d	day per	ssembly iod. 4 ackage f		·	engine and	

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Code: GDCD 2301

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Controlled Acceleration Propulsion Technology

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq., 14-15 September 1982.

Narrative:

Basic concept, timing, orbit, power, size, mass, and thermal from Ref l. Attached mode selected to provide full achievement of objectives and evaluation of data. Mission not suitable for space Shuttle due to Shuttle mission characteristics and constraints.

Code: GDCD 2301 PAYLOAD ELEMENT SYNTHESIS

CONTROLLED ACCELERATION PROPULSION TECHNOLOGY

I. <u>Mission Objective</u>

Determine the feasibility, characteristic, constraints, and interfaces of propulsion systems required for controlled acceleration of space systems and correlate the ground and space characteristics of candidate concepts.

II. Mission Description

Candidate low thrust propulsion concepts will be attached to the Space Station or associated space system if program objectives so indicate. The propulsion systems will be operated to determine the feasibility of and constraints on their use to control accelerations induced by natural and space system forces and torques. Associated diagnostics will assess plume characteristics which cannot be adequately evaluated in ground tests. The performance and lifetime will be evaluated by the use of flight and post flight inspections to correlate space and ground results. The specific propulsion concepts to be evaluated are TBD but will include resistojets operated (1) in several modes which affect their dynamic thrust characteristics and (2) possibly with various propellants.

III. Benefit

Sustained controlled acceleration environments for space systems are enabled by low thrust, precisely controlled, propulsion systems.

IV. Justification

Shuttle mission characteristics, priorities, and constraints preclude its use for the evaluation of acceleration control as well as the full accomplishment of correlation of space and ground characteristics. Ground tests are inadequate due to limited pumping, "wall effects", and the lack of sustained low "g" availability.

V. Mission Requirements and Capabilities

- A) Orbital Parameters No constraints except altitudes above those which produce an overall drag of 10-3 "g" or greater.
- B) Mass, volume, operational envelope TBD but the dry mass, including power will typically less than 25KG. The propellant mass is dependent on experiment conditions but would be expected to be less than 20KG. The volume of individual propulsion systems will be less than 0.1 M3. Operational envelope is TBD.

Page 3 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2301 PAYLOAD ELEMENT SYNTHESIS

- C) Power Continuous power during the experiment: Either AC or DC power is acceptable but DC is desirable. Other interface requirements are TBD. The magnitude will be greatly dependent on the experiment but would be about 1.5 KW if a full SOC (50KW size) concept were used at 350 KM and correspondingly smaller for smaller experimental platforms at higher altitudes.
- D) Thermal Control- Except for propellant management, there are no thermal control interface requirements. For non-cryogenic propellants it is likely that the thermal control will be contained within the experiment by design. For cryogenic propellants thermal control requirements are TBD.
- E) Attitude, Stabilization No fundamental constraints except for (1) a degree of constancy, and/or control, of accelerations on the Space System during acceleration control phases of the experiment, and (2) attitudes required to avoid impacts of the plumes from the propulsion systems.
- F) Viewing- No requirements.
- G) Environmental Constraints TBD
- H) Data Management, Communication Basic experiment control is closed loop except for commands to initiate, change state, and terminate the experiment in planned formats. No real time data required except as determined to be needed for space system safety.
- I) Crew Timelines Could be impactive if the experiment is on a manned space system. If crew movements and actions do not affect the experiment, such as on a free flyer or a loose coupled attached structure, the impact of the experiment is probably negligible.
- J) Operations Schedule, Maintenance, Lifetime No maintenance planned. Schedule and lifetime are experiment specific and are TBD.

IV. Space Station VS. Free Flyer

It is likely that uncontrolled accelerations generated on a Space Station from any source are not acceptable. Approaches to avoid such accelerations are TBD but clearly could include free flyers. If free flyers were employed the objectives of evaluation of acceleration control could be achieved without retrieval but full evaluation of the performance, lifeti.e, and plume interfaces could not, as post test data are required.

O #14 I U PAME 18 OF POOR QUALITY

		Page 1 of 3
PAYLOAD ELEMENT NAME	CODE	TYPE
Laser Propulsion Test	6 D C D 2 3 U Z	
CONTACT W. Hardy/J. Peterson MZ 21-9530		Applications
Address P.O. Box 85357		(NON-COMMBICIAL)
San Diego		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		X Technology
STATUS		
Operational Operational	pou	Operations
	Scandidate Opportunity	Tupe Number 13
		(see Table A)
No. of flights 1		Importance of the
Duration of Flight, days 100		Space Station to
OBJECTIVE To measure the thrust and specific impulse of		this Elegent
quey of ground-based measurements, and to test the life expect-	est the life expect-	1 - low value but
		Sould use 10 - vitel
		10 10
DESCRIPTION		
	test of laser propuls	the first systems level test of laser propulsion in space. It will test
tnrust and specific impulse as well as system characteristics such as so erature, propellant mass flow rate. A high-power laser, either solar-pum pumped, will be required for this mission. Life tests will be performed.	em cnaracteristics suc power laser, either sc Life tests will be per	impulse as well as system characteristics such as steady-state wall tempa mass flow rate. A high-power laser, either solar-pumped or electrically lired for this mission. Life tests will be performed.

ORIGINAL PAGE IS OF POOR QUALITY

CODE 6 D C D 2 3 0 2 Page 2 of 3	TERISTICS LEO Perigee, km LEO Tolerance + deg Any Tolerance + deg Any Ephemeris Accuracy, m			ONS rements! Realtime Of scryption Requis Command Rate (K)	Types: Analog Digital Hrs/Day (Amount) TO (Hrs/Day) Oard Storage (MBIT) Dump Frequency (Per Orbit) Found in Rate (KBPS)
	ORBIT CHARACTER Apogee, km LEO Inclination, de Nodal Angle, de	OINTING/ lew directurby Site ointing Sonting S	POUER GAC Operating Standby Peak		Data Types1 Film (Amount Live TU (Hrs On-Board Sto Data Dump Fr

ORIGINAL PAGE 19 OF POOR QUALITY

operational min max operational min max operational min max operational min max operational min max Operational min max Operational min max Operational min max NRACTERISTICS External Remote
Remote Unpressurized 0.5 H,m 0.5 H, m
Remote Unpressurized 0.5 H,m 0.5 H2 vity, g min mex 2 2 2 0.25 Service/Remove Hrs/EUA lan Hours Man/Hrs Rog.
0.5 H, m 0.5 Vity, g min max signment 7 2 0.25 Service/Remove Hrs/EUA Consumables, kg 4 Tan Hours Man/Hrs Rog.
signment 2 0.25 Service/Remove Hrs/EUA lan Hours Man/Hrs Rog.
signment 7 2 0.25 Service/Remove Hrs/EUA 1an Hours Man/Hrs Reg.
2 0.25 Service/Remove Hrs/EUA Ian Hours Man/Hrs Rog.
0.25 Service/Remove Hrs/EUA Sonsumables, kg 4 20 Ian Hours Man/Hrs Reg.
Service/Remove Hrs/EUA Sonsumables, kg 4 20 Ian Hours Man/Hrs Reg.
Service/Remove Hrs/EUA Sonsumables, kg 4 20 Ian Hours Man/Hrs Reg.
Consumables, kg 4 lan Hours Man/Hrs Rog.
lan Hours Man/Hrs
Man/Hrs

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix i

GDCD CODE 2302 ELEMENT NA	ME LASER PROPULSION TEST
ACCOMODATION: 🖾 ATTACHED 🗆	
1. STATION ACTIVATION (E.G., SET-UP/ASSEM DATE(S) 1996 INT. HRS 4	BLY/ATTACHMENT AND CHECKOUT) EVA HRS 4 EVA CREW 1
□ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL 30 DAYS TOTAL SERV	CICES 5
TMS/OTV REQUIRED	STATION HRS PER SERVICE2
☐ NOT APPLICABLE	EVA HRS PER SERVICE 2
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TO O.25 HRS PER DAY (INTERNAL) HRS PER DAY (EVA) NOT APPLICABLE 4. RECONFIGURATION INTERVAL DAYS TOTAL RECONSTRUCTORY TMS/OTV REQUIRED NOT APPLICABLE	
5. DEACTIVATION/REMOVAL	
DATE(S) 1996 INT. HRS.	EVA HRS4 EVA CREW1
□ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 TH	ROUGH 5 ABOVE)
 Set up and checkout engine (Ref GDCD 2104 and 2105) Replenish H₂ Total 8 hrs²run time per me Remove engine assembly and 	assembly with existing collector onth in two test periods

TOTAL EVA HRS 18

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2302

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Laser Propulsion Test

Reference Documents:

- 1. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq., 14-15 September 1982.
- 2. Performance and Heat Transfer Characteristics of the Laser-Heated Rocket, NASA 76-1044.
- 3. Laser Propulsion, NASA TM X-2510

Narrative:

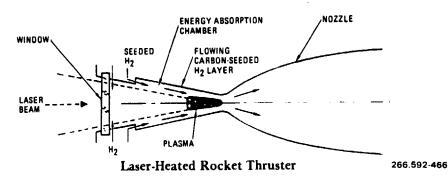
Basic concept and timing from Ref 1. Other data was derived. Man required for deployment to achieve objectives and assure safety (Ref 1). Ref 2 & 3 used for background see pp 2, 3.

Characteristics are as follows:

Laser power 50 kW Eng. thrust 0.73 Kgf ISP 1000 sec

The following description and figures are extracted from Ref 2.

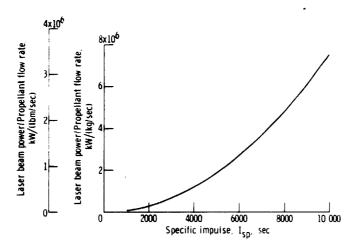
"In the operation of a laser-heated rocket thruster of the type to be discussed in this paper, the laser beam energy would enter the thruster assembly through a (solid) window, into the "energy absorption" chamber (Fig 1). The energy would be absorbed by the propellant via inverse Bremsstrahlung, resulting in formation of a high-temperature plasma. This propellant or working fluid flow would consist of a gas (i.e., hydrogen is the prime candidate because of its low molecular weight) which may or may not contain a seeding material to enhance plasma radiation absorption. The focused laser beam would sustain the high-temperature plasma within the chamber. This plasma, through conduction and radiation, would transfer heat to the remaining propellant. The high-temperature propellant would then be expanded through a conventional rocket nozzle to produce the thrust force."



Page 2 of 3 Volume II, Book 1 Appendix I

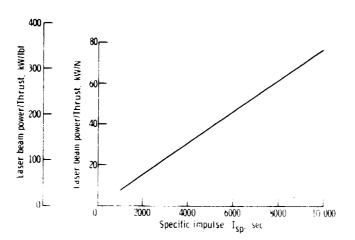
GDCD 2302 PAYLOAD ELEMENT SYNTHESIS

Code:



266.592-467

Beam Power Per Unit of Propellant Flow Rate for Various Specific Impulses



266.592-468

Beam Power Per Unit of Thrust for Various Spacific Impulses

Page 3 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2302

PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Advanced Energetics Research - IV Langley Contact: E. J. Conway

Experiment Title: Laser Propulsion Test

<u>Mission Objectives</u>: To measure the thrust and specific impulse of one or more laser propulsion systems, and to assess the adequacy of ground-based measurements, and to test the life expectancy of a laser engine.

Mission Description: The mission will be the first systems—level test of laser propulsion in space. It will test thrust and specific impulse as well as system characteristics such as steady-state wall temperature, propellant mass flow rate. A high-power laser, either solar-pumped or electrically pumped, will be required for this mission. Life tests will be performed.

Benefit: Studies show that laser propulsion offers large cost savings for OTV's operating in a heavy traffic mode. By the early 1990's, prototype laser propulsion systems will be developed and tested on the ground. Their further development will require verification by a space test of the performance in test chambers. This mission is designed to test propulsion system parameters and establish a reliable estimate of benefit.

<u>Justification</u>: Several studies have shown that laser propulsion for OTV applications could be much less expensive than chemical propulsion. Without aggresive research, technology development will not be realized. This mission is designed to demonstrate and advance the state of the art in laser propulsion.

Mission Requirements and Capability: An adequate laser power source operating at the correct optical frequency will be required. Laser pointing and tracking will not be required since transmission can be over a distance of approximately the longest dimension of the space station. Adjustment, control, alignment, and repair are expected to require manned interaction. Depending upon the magnitude of the laser thrust, an opposed non-laser engine may be required.

Space Station vs. Free Flyer: These tests will require man for deployment, to achieve and measure maximum performance and to assure safety for the spacecraft and the laser propulsion system. Because it requires a high-power laser, either solar-pumped (requiring the concentrator) or electrically jumped (requiring a large photovoltaic panel), the resources of a space station will be required.

Section 3.5

Discipline Control & Human Factors

GDCD ID NO.	PAYLOAD ELEMENT NAME
2401	Manipulator Controls Technology
2042	Advanced EVA Technology

l		
Ŧ	CODE	TYPE
Manipulator Controls lechnology		Science &
CONTACT W. Hardy/J. Peterson MZ 21-9530 Name General Dynamics Convair Division		Applications (non-commercial)
San Diego, CA 92138		-Commercial
Telephone (619) 277-8900, Ext. 3778/2130		X Technology Development
nal	pou	Operations
☐ ☐ Approved ☐ ☐ Candidate ☐ ☐ Opportuni	Candidate Opportunity	
First flight, yr 1991 No. of flights 1 Duration of Flight, days 365		(see Table A) Importance of the Space Station to
OBJECTIVE To determine the characteristics and limitations interactive and adaptive control technology applied to space	s and limitations of applied to space	
teleoperator systems. To develop a quantitative data base with which to compare and predict task performance with teleoperation vs space suit.	itive data base with ice with teleopera-	1 = low value but could use 10 = vital
		Scale 1 - 10 6
DESCRIPTION A lightweight low-inertia dual arm manipulator system will be attached to the Space Station. The manipulator system will be controlled from a teleopyrator control station in the Space Station, through a computer interface, using both supervisory and direct control modes. Initially, tests within a Space Station laboratory will include evaluation of system response to validate ground based models, to identify system parameters, and to develop adaptive control algorithms for 0-g operations. Experiments will provide data on operator restraints, workload, mobility, and response to bilateral forces. Baseline test will be conducted to compare task performance using the teleoperator with performance in a space suit. In addition to tests within the Space Station, the teleoperator system will be attached to a carrier vehicle such as TMS to develop procedures for remote operations such as construction, inspection and repair.	l arm manipulator system terface, using both surerface, using both surerface, using both surerface, using both surerface, using both surerface will proposerator with perfect the teleoperator system termote operatives.	the space Station arm manipulator system will be attached to the nanipulator system will be controlled from a teleopyrator control station, through a computer interface, using both supervisory and direct control ststs within a Space Station laboratory will include evaluation of system ground based models, to identify system parameters, and to develop adapthms for 0-g operations. Experiments will provide data on operator remobility, and response to bilateral forces. Baseline test will be conducterformance using the teleoperator with performance in a space suit. In ithin the Space Station, the teleoperator system will be attached to a carthin the Space Station, the teleoperator system will be attached to a carthin the Space Station, the teleoperator system will be attached in in-

ORIGINAL PAGE 19 OF POOR QUALITY

GDC D 2 4 0 1 Page 2 of 3		☐Solar ☐EarthField of view, deg	U Duration, hrs/day ☐Continuous	ine Other Frequency (MHZ)	Digital □Hrs/Day Voice (Hrs/Day) Other Other State (MMZ)
	ORBIT CHARACTERISTICS Apogee, km LEO Periges, km Inclination, deg Any Nodel Angle, deg Escape do Required, m/s	ON Inertial Coun arc sec (Jitter) arc	OUER Ac XDC Power, Operating 3150 Power, Standby Peak	NS Tements! Realtime XOf Cryption Requis Command Rate (Ki	Data Types! Analog Dil Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit)

6.0.C.0.2.4.0.1 Page 3 of 3
RACTERISTICS External Remote
Lym 2 Hym Stowed Lym 3 U,m 2 Hym 600 Launch mass, kg Consumables Tunes
Acceleration
CREW REQUIREMENTS Crew Size Crew Size
is (See Table B) SKILL
Hrs/Day 0.2 0.2
EUA X YES UNO Reason Set Up/Operations Hrs/EUA 20
Returnables, kg
CONFIGURATION CHANGES: Interval, day Returnables. kg
ctions Crew scheduling will be necess be flexible. Operations outside the Spink for TV and command/feedback will be other fivee-flyer). Outputs of system wia analysis capability is desirable. Depicons.

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GOCD CODE 2401 ELEMEN	NT NAMEMANI PULATOR CONTROLS
ACCOMODATION: 🖾 ATTACHED	FREE FLYER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/A	ASSEMBLY/ATTACHMENT AND CHECKOUT)
DATE(S) 1991 INT. HRS	EVA HRS 8 EVA CREW 2
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY	n
INTERVAL DAYS TOTAL	SERVICES
TMS/OTV REQUIRED	STATION HRS PER SERVICE
M NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (A)	VG. TIME FOR MONITOR, INSPECT, ETC.)
0.38 HRS PER DAY (INTERNAL)	138 hrs/365 days
0.03 HRS PER DAY (EVA)	·12 hrs/365 days
☐ NOT APPLICABLE	•
4. RECONFIGURATION	
INTERVAL DAYS TOTA	L RECONFIGS.
☐ TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
Was seen also and a seen a seen a seen a seen a seen a seen a seen a seen a seen a seen a seen a seen a seen a	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) 1992 INT. HRS	EVA HRS EVA CREW
□ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN	I 1 THROUGH 5 ABOVE)
See payload element synt	chesis sheet.

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Code: GDCD 2401

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Manipulator Controls Technology

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hg., 14-15 September 1982, Attachment A, p 60.

Narrative:

This payload element implements the experiment objectives described in Ref 1.

Initial experiments are conducted within a Space Station Laboratory using two 3m long arms.

Later tests will be performed with two 6m long arms attached to a carrier vehicle such as a TMS. The weight and power estimates shown on the data sheets are for this latter case. Mass and power estimates are given in Table 2401-1.

The suited man performance equivalence tests will require 8 hours of EVA to set up the task board and 4 hours of EVA to conduct the test. Table 2401-2 lists sthe man hour utilization for each phase of the experiment.

Table 2401-1. Mass and Power Estimates*

A. Internal Tests: (2) 3m Arms (1) controls, Displays	Mass (kg) 260 50	Power (W) 1,000 150
Totals:	310	1,150
B. External Tests: (2) 6m Arms (1) Controls, Displays	550 50	3,000 150
Totals:	600	3,150

*Estimated by Spar Ltd.

Page 2 of 4 Volume II, Book 1 Appendix I

Code: GDCD 2401

PAYLOAD ELEMENT SYNTHESIS

Table 2401-2. Manhour Utilization

1.	Laboratory Expt.		Manhours
1A.	Short Arm Tests		
	Set up & conduct 8 test runs.		
	2 crewmen required x_54 hrs each =		108
1B.			
	Suit up and conduct taskboard tests		_
	2 crewmen required x 3 hrs each =		6
2.	TMS Conversion		
2A.	Adapt Manipulators To TMS		
	2 men x 4 hrs =		8
2B.	Checkout Operation		
	2 men x 2 hrs =		4
2C.	Locate Task Board Externally		
	2 EVA crewmer x 4 hrs =		8 (EVA)
3.	External Experiments		
3A.	TMS Perf. Test		
0.11	2 men x 4 hrs =		8
3B.	EVA - Man Perf. Test		-
	1 man EVA 4 hrs =		4 (EVA)
	1 man IVA 4 hrs =		4
			3.50
		Total:	150
			(including
			12 hrs EVA)

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Code: GDCD 2401

PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Space Teleoperator Systems Research Langley Contact: A. J. Meintel

Experiment Title: Manipulator Controls Technology

Mission Objectives: 1. Determine the characteristics and limitations of interactive and adaptive control technology applied to space teleoperator systems.

2. To develop a quantitative data base with which to compare and predict task performance with teleoperation and in a space suit.

Mission Description: A lightweight low-inertia dual-arm manipulator system will be attached to the space station or associated structure. The manipulator system will be controlled from a teleoperator control station in the space station, through a computer interface, using both supervisory and direct control modes.

Initially, the manipulator system will be in a space station laboratory. Tests within the laboratory will include evaluation of system response-to validate ground based models, to identify system parameters, and to develop adaptive control algorithms for zero g operations. Experiments will provide data on operator restraints, workload, mobility, and response to bilateral forces. Baseline tests will be conducted to compare task performance using the teleoperator with performance in a space suit.

In addition to tests within the space station the teleoperator system will be attached to a carrier vehicle such as TMS to develop the technology and integrated procedures required for remote operations such as construction, inspection, materials transfer, and repair.

Benefit: A teleoperation system will perform activities outside the space station (EVA) over a long time period, over long distances, with precision, without human risk, and with replinishable electrical power the only consumable. A teleoperator can capture, transport, orient, and stabilize materials and payloads needed for EVA operations.

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Code: GDCD 2401

PAYLOAD ELEMENT SYNTHESIS

Justification: The Shuttle RMS is the first space teleoperator. It also illustrates the handicap in development of space teleoperator technology. The RMS, like all manipulators, is a flexible, coupled, nonlinear system. The stabilization and control problems are analogous to those of other large space structures. The RMS can (and had been) mathematically modelled, but because it is designed for zero g it cannot be tested under 1g to validate its characteristics and develop control laws that will improve its response and stability. Neutral buoyancy tests would require structural changes and would have large viscous effects. A space station would provide the time to systematically validate the math models and improve the performance based on the true measured characteristics of a space-based teleoperator system.

Also, many teleoperator systems employ bilateral force teedback because it gives the operator an indication of the forces exerted on the manipulator end effector or tool. The RMS is not a force reflecting system and the aft flight deck has limited space. The space station would have room for conventional and bilateral controllers, and the effects of forces transmitted to the operator and the restraints required for zero g could be evaluated.

Mission Requirements and Capabilities:

Mass, volume, operational envelope- All configuration dependent. TBD.

Data management, communication- Outputs of system will be monitored and some parameters recorded. Onboard data analysis capability desirable.

RF link for TV and command/feedback required for remote teleoperator control (with TMS or other free-flyer).

Crew Timeline- Crew scheduling will be necessary, but teleoperation technology studies schedule can be flexible. Operations outside space station will significantly effect crew timelines.

	Page 1 of 3
PAYLOAD ELEMENT NAME	TYPE
Advanced EVA Technology	Science A
	Applications (non-commercial)
Hddrass P.O. Box 85357 San Diego, CA 92138	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	X Tachnology Develorment
STATUS Operational Planned	Operations
a u	Type Number 14
First flight, yr 1990 No. of flights 1 Duration of Flight, days 3600	Importance of the Space Station to
OBJECTIVE Develop the tools, EVA workstations, mobility aids, and procedures to perform diverse EVA tasks (station construction, OTV/satellite servicing, emergencies), effectively, effi-	• 1
ciently, safely, on a continuing basis for as many as 24 sortles per week.	10
	Scale 1 - 10 8
DESCRIPTION In conjunction with life sciences payload element GDCD 0322, new tools for Space Station construction, maintenance and repair, restraint systems, mobility aids, EVA work platforms, new suit components (initially, the new 8 psi "hard" suit) and other EVA equipment and procedures will be used and evaluated. This payload will consist of stowed equipment and electrical/data interface for remote control, monitoring and display. Advanced EVA tools and equipment will be developed and used for assembly/construction of large space structures and systems on the Space Station throughout the decade.	t GDCD 0322, new tools for systems, mobility aids, EVA "hard" suit) and other EVA oad will consist of stowed nitoring and display. Advanced y/construction of large space ade.

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m			<u> </u>		
6.0.c.0.2.4.0.2 Page 2 of 3		50	Continuous	Frequency (MHZ)	(ZHW) T
CODE	Tolerance + Tolerance + Ephemeric Accuracy.	Solar Earth Field of view, deg	U Duration, hrs/day	Ine Cother red	Digital Hra/Day Voice (Hrs/Day) Other bit) Downlink Frequency (MHZ)
	BIT CHARACTERISTICS ogeo, km LEO Perigeo, km clination, deg Any dal Angle, deg cape dV Required, m/s	ertial sec itter)arc	Dc Power,	MUNICATIONS ng requirements; Realtime 00f yption/Decryption Requirents nk Req.:Command Rate (K) oard Data Processing Recription	Data Types! Analog Di Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit)

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m		OF POOR	R QUA	\LITY	, 				
G D C D 2 4 0 2 Page 3 of 3	Passive Pass	L CHARACTERISTICS In External Remote tion Pressurized Unpressurized L.m 1.3 U.m 1.3 H.m L.m 1.3 H.m Launch mass, kg Consumables Types Acceleration sensitivity, a min	1 Task Assignment EVA	B) SKILL LEVEL	Hrs/Day 0.02	NO Rouson Operations Hrs/EUA 160	NTENANCE Val, days Consumables, kg	WGEStinterval, day Deliverables, kg	IIONS/See Instructions This payload element is interamance and Productivity. Required EVA time of 0.04 Hr/Day ar In later years, weight could increase to 812 Kg and 4.0 cu ools. This payload element supports a variety of assembly atructures on the Station, e.g., GDCD 2005, 2006, 2007, 0001
	THERMAL []Active Temperature, deg Heat Rejection, w	EQUIPMENT PHYSICA Location: Trte Equipment ID/Func	CREU REQUIREMENTS Crew Size	Skills (See Table		EUA XVES	SERUICING/MAINTEN, SERUICE Interval, Returnably	CONFIGURATION CHA	SPECIAL CONSIDERANGOCD 0322, EVA Perforthis payload element.includes spares and tactivities of large s

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2402	ELEMENT NAME	ADVANCE	D EVA	TECHNOLOG	Υ
ACCOMODATION: ATT	ACHED	FLYER	□ 0TV 0	PS	
1. STATION ACTIVATION (E.G	i., SET-UP/ASSEMBLY	/ATTACHMEN	IT AND CH	HECKOUT)	
DATE(S) 1990 IN	r. HRS	EVA HRS		_ EVA CREW_	
				- .	
NOT APPLICABLE					
2. SERVICE (E.G., REPLENISH	(RESUPPLY)				
INTERVAL DAYS	TOTAL SERVICES		-		
TMS/OTV REQUIRED		STAT	ION HRS F	PER SERVICE	
▼ NOT APPLICABLE		EVA	IRS PER S	SERVICE	
		EVA (CREW SIZI	Ε .	 -
3. STATION OPERATIONAL SE	JPPORT (AVG. TIME F	OR MONITOR	R, INSPEC	T, ETC.)	
.02 HRS PER DAY (NTERNAL)				
.04 HRS PER DAY (EVA) Total of 1	60 hours			
☐ NOT APPLICABLE					
4. RECONFIGURATION					
INTERVAL DAYS	TOTAL RECONF	IGS.			
TMS/OTV REQUIRED		STATI	ON HRS P	ER RECONFIG	j.
☑ NOT APPLICABLE		EVA H	RS PER R	ECONFIG	
		EVA C	REW SIZE	_	····
5. DEACTIVATION/REMOVAL					
DATE(S)INT	. HRS 6	VA HRS		EVA CREW _	
X NOT APPLICABLE					
6. NOTES (BRIEFLY DESCRIBE	E TASKS IN 1 THROU	GH 5 ABOVE)			
 No assembly requ EVA = 20 Continuing exper 	times, 2 men	for 4 hr er year 2	. each 2000	time	

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2402 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Advanced EVA Technology

Reference Documents:

1. Space Station Technology Readiness by R.F. Carlisle and J.H. Romero. ASME National Marketing, Phoenix, Arizona, November 1982

- Space Station Environmental Control and Life Support System. Preliminary Conceptional Design by C.H. Lin. NASA JSC Doc No. CSD-53-059, JSC-17727, 9/82
- 3. Military Space Systems Technology Model. AlAA Man-In-Space System Panel Report, Alburquerque, N.M. Revised Draft, September 23, 1982
- 4. Space Operation Center Systems Analysis. Final Report. Volume II. Boeing Aerospace Company. NASA Contractor Report 160944 (JSC). July 6, 1982.

Narrative:

Future EVA space activity shows a diversity of work on a continuing basis, exceeding past work, including space station construction, OTV and satellite servicing, as well as emergences requiring immediate EVA activity. Improved EVA equipment, adapted to the new activities, will need to be tested under the required continuing basis, which will not be possible from periodic space shuttle-based EVAs.

Planned EVA technology to enhance space work encompasses items such as (see Ref 1, p 12 and Ref 2, p 86):

Suit construction: Improved mobility

Suit life support system: Improved internal pressure (8 psi

vs 4 psi), and atmosphere composition

 $(0_2, N_2 \text{ vs } 0_2 \text{ today})$

Work tools, maneuvering unit: Enhanced mission abilities (powered

vs no power) greater operating dis-

tances with an improved manned

maneuvering unit.

The higher pressure and component gases avoid lengthy pre-breathing (bend avoidance) required for existing space suits.

Page 2 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2402

PAYLOAD ELEMENT SYNTHESIS

Ref 3 lists elapsed time through manufacturing and test for developing eleven EVA technology related items; namely:

EMU Helmet (3yrs)
 EMU Gloves (3 yrs)
 Refueling System (4 yrs)
 Hand Tools (3 yrs)
 Prebreathe Eliminator (6 yrs)
 Hi Δ∨MMU (8 yrs)
 Hand-Held Power Tool (3 yrs)
 Diagnostic & Checkout (6 yrs)
 Renhanced Computer (11 yrs)
 Rengenerable CO₂ (5 yrs)
 Non Venting Heat Sink (3 yrs)

Ref 3 describes safety aspects related to EVA (p 4-22).

Integration of EVA and Space Station are described in Ref 2, p 6, and following:

- (a) preparations (d) checkout (b) equipment storage (e) maintenance
- (c) recharge (f) past EVA activities
- Storage of EMU spare parts and tools to be located in the maintenance area.
- Checkout of EVA equipment, repairs, etc is to be done in the work area

Eva activity level described by NASA in Ref 2, p 7 is:

- Capability of two EVAs simultaneously in early years
- Capability of four Evas simultaneously in later years
- EVA frequency: Two, 2-man sorties/day, 6 days/week for a total of 24 sorties/week
- Maximum duration of 8 hours/sortie

The Convair mission data for this payload shows an 8-hour/day estimate for the early years, rather than the 16 hours indicated above.

Table 2402-1 summarizes weight and volume for the space suits. See Ref 3, pp 3-4 for data/suit. Table 1 contains an estimate of suits required to which is added a judgemental 30% weight and volume increase for spares and tools.

Code: GDCD 2402

PAYLOAD ELEMENT SYNTHESIS

Existing space suits use a replaceable lithium hydroxide (Li OH) canister (6.5 1b/EVA) to remove CO_2 . If the canister use is kept, corresponding weight (24 sorties/week) = 1900 1b (849 kg). This is a significant amount relative to suit weights in Figure 2402-1. A regenerable CO_2 for extensive EVAs is one of the planned items listed previously. For the purpose of weight estimates, the above assumption of a 30% increase applied in Figure 1 is taken to approximate the inclusion of any Li OH.

Power requirements in Figure 2402-1 is taken at 30 watts/suit (battery) based on a phone discussion with Mr. A. Brouillet of Hamilton Standard Company, an EVA suit manufacturer.

Table 2402-1. Space Suit Data (8 psi, 02 IN2)

Year	Crew Sizes	No. of Suits	Wt. Per Suit, KG *	Volum Per Suit, cu.m*	Sum Weight, kg **	Sum Volume, cu.m **	Sum Power, W
Early	4	3	104	0.5	406	2.0	100
Later	8	6	104	0.5	812	4.0	180

^{*} Ref 3, pp 3-48

^{**} Includes 30% extra for spares and tools

Section 3.6

Discipline Space Station Systems & Operations

GDCD ID NO.	PAYLOAD ELEMENT NAME
2501	Liquid Droplet Radiator
2502	Advanced Control Device
2503	Space Component Lifetime Technology
2504	OTV Payload Handling
2505	Pdyload Servicing and Repair
2506	OTV Propellant Transfer and Storage
2507	OTV Propellant Reliquification
2508	OTV Docking and Berthing
2509	OTV Maintenance
2510	Tether Dynamics Technology

rople	TYPE
id Droplet Radiator ACT W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division	
АСТ	
	Applications (non-commercial)
Hadrass P.O. Box 85357 San Diego, CA 92138	- Commercial
Telephone (619) 277-8900, Ext. 3778/2130	X Technology
☐ Operational ☐ Planned ☐ Approved ☒ Candidate	rations
UOpportunity.	Type Number 15
First flight, yr 1996 No. of flights 1 Duration of Flight, days 365	Importance of the Space Station to
OBJECTIVE Demonstration and verification of an advanced	
Liquid Droplet space radiator concept under operational Space Station conditions (0-g, space vacuum, space plasma, attitude	1 . low value but
control maneuvering perturbation, long duration operations). Determine operational characteristics, constraints, and effects	10 - vital
of space station/radiator interface.	Scale 1 - 10
DESCRIPTION	
The liquid droplet radiator systems could be connected to the Space Station thermal management system. The system would be installed as an auxiliary experimental heat rejection system. Waste heat load would be supplied by the Space Station commensurate to the size of the liquid droplet radiator system. It would operate at actual Space Station radiator conditions of inlet and outlet temperature, etc. Performance would be evaluated for efficiency of waste heat rejection, response, temperature distribution controllability, flow rate, potential of loss of working fluid, and space station contamination due to vaporization and maneuvering. O-g effects on droplet generation, trajectory and collection efficiency would be determined, as well as constraint on operation control and performance. Performance, failure modes, and lifetime potential will be evaluated.	management system. The system would uld be supplied by the Space Station actual Space Station radiator. efficiency of waste heat rejection, working fluid, and space station n, trajectory and collection rmance. Performance, failure modes,

•	GODE GOCOSSOI Page 2 of 3
ORBIT CHARACTERISTICS Hpogee, km LEO Perigee, km Inclination, deg Any Nodel Angle, deg	Tolerance + Tolerance + Ephemeris Accuracy, m
SORIENTAT	□ Solar □ Earth
t to C	ire sec/sec
ပ္	er, U Duration, hrs/day
Standby 1000 Standby 1000 Peak	Froques
MMUNICATIONS Ing requirements; Cyption/Decryption Relink Req.: Command Rate Soard Data Processing	Required Le (KBS) ng Required
Data Types! Analog Die Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) 1.0	Orbit) Digital Hrs/Day Other Other Orbit) Downlink Frequency (MHZ)

ORIGINAL PACK TO OF POOR QUALITY

n		POOR CONCIL	, .			, ,	, ,		
Page 3 of		Stowed	Concept			20	·	7.0	
)E 0 c 0 2 5 0 1	× × × ×		Verify Radiator Concept			Hrs/EUA		Man/Hrs Rog.	quire evalua trequired to at rejection stem would be ce station. I ipated that required.
CODE 6 0	X X X X A A A A A A A A A A A A A A A A	33urized H. H. 1000					Consummbles, kg Man Hours		on would re control is her waste he luation. Sy of the spa of the spa It is antic
•	#T##	nal Remote urized⊠Unpres U, m U, m kg kg	Task Assignment	1	0.1	Deployment/Removal	Consum	- 1	
	ational m ational m ational m	External Remote Pressurized Win Him Him Him Him Him Him hass, kg bles Types		SKILL	Hrs/Day	Rouson Depl		Aup	Up, shutdown, full and part load operation. Experiment control is require evaluation, terminate operation, and change operating level per waste heat rejection, terminate operation, and change operating level per waste heat rejection cquisition is required for operational control and evaluation. System would erate within the attitude and stabilization constraints of the space station of the liquid droplet steam collector may be required. It is anticipated that effected through motorized control, method TBU. No thermal control required.
·	Passive c operationa non-operationa operationa	CHARACT L, m L, m L, m L, m Consume Consume	1	8)		ONO Re	ANCE days os, kg	ATION CHANGES: Interval,	IONS/See od part load tion, and cled for opertude and strude and s
	m 3	PHYSICA Inte	REQUIREMENTS Size	oe Tablo			AMAINTENE ntorval, oturnable	TION CHAP	up, shutdown, full an tion, terminate opera acquisition is requirerate within the attion the liquid droplet effected through moto
	THERMAL []Active Temperature, deg Heat Rejection,	EQUIPMENT Location: Equipment	CREU REQU Craw Size	Skills (See Table		EUA X YES	SERVICING/MAINTEN SERVICE:Interval, Returnabl	CONFIGURATION CHA	up, shutdown, full and part load operation. Expertion, terminate operation, and change operating lacquisition is required for operational control acquisition is required for operational control erate within the attitude and stabilization const of the liquid droplet steam collector may be requefected through motorized control, method TBU.

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2501 ELEMENT NAME LIQ	UID DROPLET RADIATOR
ACCOMODATION: X ATTACHED TREE FLY	ER 🔲 OTV ÚPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATT)	ACHMENT AND CHECKOUT)
DATE(S) 1996 INT. HRS EVA	HRS 12 EVA CREW 2
	
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
☑ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR N	IONITOR, INSPECT, ETC.)
0.2 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
☐ NOT APPLICABLE	•
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONFIGS.	
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) 1997 INT. HRS EVA H	IRS 8 EVA CREW 2
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	ABOVE)
 Deployment of collector, plumbing Monitoring of Performance Removal of experiment 	

C-10

TOTAL EVA HRS 20

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Code: GDCD 2501

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Liquid Droplet Radiator (LDR).

Reference Documents:

- 1. Technology Development Missions Space Station NAAO Orientation Meeting NASA Hq., 14-15 September 1982.
- 2. The Liquid Droplet Radiator An Ultra Light Heat Rejection System For Efficient Energy Conversion In Space, A.T. Mattick and A. Hertzberg, Acta Astronautica Vol. 9 pp 165-172, 1982.

Narrative:

The objective, description and special considerations for this payload element are from Ref (1).

The concept sketch for LDR generation and collector are from Ref (2).

The remaining data for this payload element is derived.

Ref (2) identifies unique interfaces, to include:

- a. Contamination of spacecraft surfaces and radiation fluid (typical fluids are tin, tin-lead, oils, etc)
- b. Droplet charging from the space station which could effect droplet trajectory
- c. Radiator orientation to insure droplet pattern edge-on to the sun and integration and coordination of station attitude changes with droplet collector position.

Methods of generating and collecting the droplets are shown in Figure 2501-1 from Ref (2) and as follows: "The generator is a pressurized plenum with an array of nozzles to form liquid jets which break up into droplets via surface tension instability. A vibrator may be used to induce pertubations in the emerging jets to control droplet size and spacing."

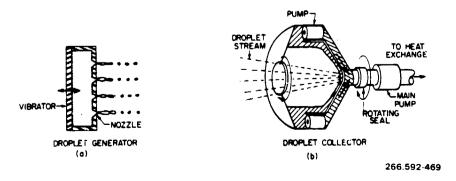


Figure 2501-1. LDR Components, (a) Generator; (b) Collector

Code: GDCD 2501 PAYLOAD ELEMENT SYNTHESIS

LIQUID DROPLET RADIATOR

I. Mission Objective

Demonstration and technical verification of an advanced Liquid Droplet space radiator concept under acutal operational space station conditions (zero-gravity, space vacuum, space plasma, attitude control manuevering perturbation, etc., during long duration operations). Determine operational characteristics, constraints and effects of space station/radiator interface.

II. Mission Description

The candidate liquid droplet radiator systems could be intergrated/connected to the space station thermal management system at the heat rejection interface point. The system assembly would be installed as an auxilliary experimental heat rejection system. Waste heat load would be supplied by the space station (as an option a separate heat source could be used) commensurate to the size of the liquid droplet radiator system. It would operate at actual space station radiator conditions of inlet and outlet temperature, zero gravity, vacuum, solar radiation, attitude correction and maneuvering perturbations and with the interface of space plasma. Performance would be evaluated for efficiency of waste heat rejection, response, temperature distribution controllability, flow rate, potential of loss of working fluid and space station contamination due to vaporization and manuevering and effect of space plasma interface on liquid droplet streams trajectory. Zero-gravity effects on droplet generation, trajectory and collection efficiency would be determined. Constraint on operation control and performance will be determined. Performance, failure modes, and lifetime potential will be evaluated using operational data to correlate space and ground test data. Mission would require evaluation under startup, shutdown, full and part load operation. A typical system configuration is shown on figure 1.

III. Benefits

Technology verification/demonstration of advanced radiator system less that 1/4 of the weight of flat plate, tube-fin and hear-pipe radiator designs. Radiator concept does not require surface coatings or armor-plate protection. Radiating area is impervious to micro meteroid damage. Liquid droplet radiator is suitable for low temperature (300K) and high temperature (1000K) NASA and DOD applications in KW and MW range. System is deployable, offers compact stowed configuration and can be designed to survive launch environment.

IV. Justification

Evaluation/technical verification of a radiator for space

Page 3 of 4 Volume II, Book 1 Appendix I

Code: GDCD 2501

PAYLOAD ELEMENT SYNTHESIS

application requires sustained operation for a long duration under actual spacecraft operating conditions and space environment of zero-G, solar radiation, vacuum, space plasma and the spacecraft steady state, thermal and manuevering operating modes.

Ground testing lacks sustained zero-G, space plasma and solar radiation availability and does not adequately simulate structual forces or manuevering modes. Shuttle mission objectives, limited mission duration and mission priorities preclude its use for sustained long duration testing and may also limit the size of the experiment.

V. Misson Requirements and Capabilities

- A) Orbital Parameters No constraints. Would operate at space station altitude.
- B) Mass, Volume, Operational Envelope TBD. The test radiator systems should be of specific size, compatible with the space station to provide design/operational data that can be used for scaling to a larger system.
- C) Power Ac-DC continuous electric power would be required for pumping and controls. Other interface requirements are TBD. Magnitude of power requirements are dependent on the size of the experiment.
- D) Thermal Control The equipment could be designed for rejection of a portion of spacecraft heat load. It is unlikely that thermal control provisions would be required for any of itx components except instrumentation.
- E) Attitude, Stabilization The system would be designed to operate within the attitude and stabilization constraints of the space station. Position control of the liquid droplet steam collector may be required. It is anticipated that this would be effected through motorized control.. Method is TBD.
- F) Viewing TBD
- G) Environmental Constraints TBD
- H) Data Management, Communication Experiment control is required to initiate operation, terminate operation and change operating level per waste heat rejection demands. Data acquisition is required for operational control and evaluation.
- I) Crew Timeline TBD. Crew resources may be needed for conduct of experiment at scheduled times.
- J) Operations Schedule, Maintenance, Lifetime No maintenance is planned. Schedule and lifetime are experiment specific and are TBD.

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Code: GDCD 2501

PAYLOAD ELEMENT SYNTHESIS

K) Economic or Performance Benefits Achieved Through Use of a Space Station - A space radiator system is operation with power production for long durations. The use of a space station for evaluation of this concept offers the potential of long term testing (not available with shuttle) needed for scaling.

L) Space Station VS Free Flying Platform - TBD.

	Page 1 of 3
PAYLOAD ELEMENT NAME	
Control Device	Science L
erson MZ 21-9530 s Convair Division	Applications (non-commercial)
San Diego, CA 92138	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	X Technology
STATUS	140EQ01000
nal	Operations
- Approved XCandidate	•
First flight, yr 1994	(See Table A)
No. of flights 1	ſ
1	Space Station to
_	
netically suspended momentum rings) required by advanced Space	1 - low value but
Station configurations.	could use 10 = vital
	Scale 1 - 10 5
DESCRIPTION Advanced control devices will be provided as selectable	ctable alternatives to opera-
tional control devices. Various advanced devices will be evaluated with the operational sys-	d with the operational sys-
tem serving as a backup. Testing will be performed on a large multibody, flexible structure which could be the same one deployed as payload GDCD 2005.	tibody, flexible structure

M			T		
2.5.0.2 Page 2 of 3			Continuous	, (ZHW) Å:	HZ)
- 1	ORBIT CHARACTERISTICS Apogee, km LEO Perigee, km LEO Tolerance + Inclination, deg Any Tolerance + Nodal Angle, deg Ephemeris Accuracy, m	OINTING/ORIENTATION Low direction Inertial Solar Earth ruth Sites (If known) ointing accuracy, arc sec ointing Stability (Jitter) arc sec/sec becial Restrictions (Avoidance)	rating ndby k	MUNICATIONS ng requirements: \times \times \times \times 0 f \times \	Data Types: Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)
	ORBI Apog Incl	POINTING, Uiew dire Truth Sit Pointing Pointing	POUER XA		

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2502 ELEMENT NAME ADV	VANCED CONTROL DEVICE
ACCOMODATION: 🖾 ATTACHED 🗆 FREE FLY	
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTA	ACHMENT AND CHECKOUT)
DATE(S) 1992 INT. HRS EVA	HRS 12 EVA CREW 2
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICES	
TMS/OTV REQUIRED	STATION HRS PER SERVICE
M NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR N	IONITOR, INSPECT, ETC.)
0.2 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL360 DAYS TOTAL RECONFIGS.	1
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☐ NOT APPLICABLE	EVA HRS PER RECONFIG. 12
•	EVA CREW SIZE 2
5. DEACTIVATION/REMOVAL	
DATE(S) 1994 INT. HRS EVA H	IRS 12 EVA CREW 2
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5	ABOVE)
1. Assembly and attachment	
3. Monitoring and recording	
5. Removal and repackaging	

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2502

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Advanced Control Device

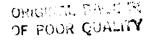
Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq., 14-15 September 1982.

Narrative:

Payload element objective, description, accommodation mode, and relationship to large structural payload element (GDCD 2005) taken from Ref 1.

All other data derived.



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Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2502

PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title:

Langley Contact:

Spacecraft Control Technology Development

C. R. Keckler

Experiment Title:

Advanced Control Device Technology Demonstration

Mission Objectives:

Evaluate momentum storage control devices (e.g., third generation control moment gyros (CMG's), second generation magnetically suspended momentum rights (AMCD's)) required by advanced space station configurations.

Mission Description:

Advanced control devices will be provided as selectable alternatives to operational control devices. Various advanced devices will be evaluated with the operational system serving as a backup.

Benefit:

Control device technology must continue to evolve as space stations become more complex. Advanced devices can be qualified in space using the operational system to insure safety.

Justification:

Technology supports space station evolution and therefore requires the space station environment for realistic dynamic testing and long duration life testing.

Mission Requirements and Capability:

Essentially the same as the operational control devices. Expanded software is anticipated for the dual hardware interfaces.

Space Station vs. Free Flyer:

Validation on the vehicle of intended application is desirable. Life testing could be accomplished on a free flyer; dynamic control testing must be performed on a large, multibody, flexible structure.

				, ' • • • • • • • • • • • • • • • • • •			Volume II, Book 1 Appendix I
TYPE	Applications (non-commercial)	X Technology Development	sration Number	(see Table A) Importance of the Space Station to this Element	1 - low value but could use 10 - vital	Scale 1 - 10 8	of critical components sel- ition in the space environ- battery power units; space is; and microwave amplifier
NT NAME CODE C D 2 5 0 3	W. Hardy/J. Peterson MZ 21-9530 General Dynamics Convair Division P.O. Box 85357 San Diego, CA 92138	(619) 277-8900, Ext. 3778/2130	184	r 1990 1 1 3650+	To provide a technology base for the development of diverse hardware components for which a multi-year operational lifetime under space conditions is specified.		ESCRIPTION The proposed mission would characterize the performance lifetime of critical components selected from varied space technologies. Components requiring evaluation in the space environment include primary propulsion systems; solar cell and chemical battery power units; space qualified solid film lubricants; laser and conventional spin gyros; and microwave amplifier cathodes.
PAYLOAD ELEMENT NAME Space Component Lifetime	CONTACT N. H. H. Namo Gene Address P.O. San	Telephone (619)	Operational	First flight, y No. of flights Duration of Fli OBJECTIVE	To provide a tec hardware compone under space conc		DESCRIPTION The proposed mission would ected from varied space terment include primary propuqualified soiid film lubric cathodes.

ORIGINAL PRODUCTION OF POOR QUALITY

m		, , , , , , , , , , , , , , , , , , , 	TOOK QUALIT	•	·	_
CODE 6.0 C.0 2.5 0.3 Page 2 of	Perigee, km LEO Tolerance + Any Any Ephemeris Accuracy, m	POINTING/ORIENTATION Usew direction Inertial Solar Earth Truth Sites (If known) Pointing accuracy, arc sec Field of view, deg Pointing Stability (Jitter) arc sec/sec	POUER Operating Standby Pout Pout Ooltage, U Frequency, Hz	ATA/COMMUNICATIONS Onttoring requirements! One One One One One One One One One One	Data Types: Analog Digital Hrs/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Data Dump Frequency (Per Orbit)	proing hate (Nors)

OFFICER CONTRACTOR

C		OF PCOR Quin-							
Page 3 of		Stowed Deployed	ical Component			152		8	е components.
	X X X X X X X X X X X X X X X X X X X	1zed 0.2 300 0.2	Evaluate Critical Performance			Hrs/EUA	. kg	Man/Hrs Rod	PECIAL CONSIDERATIONS/Son Instructions Size is unit size for each of six components. Weight is for six representative components.
		Remote O.2 H.m O.2 H.m	Task Assignment	1 2	0.2	Konson Lonfiguration Change	- Constantion,	180 kg	n s leight is for si
	Passive operational min- non-operational min- operational min-	CHARACTERISTICS Laternal On Pressurized L,m 0.2 U,m L,m 0.2 U,m Launch mass, kg Sonsumables Types		SKILL LEVEL	Hrs/Day	onson Contigu		day,	Instructions × components. Were
	g C Pas	PHYSICAL CHARACTERIST Internal X Extention Pressible O.2 L, m 0.2 L, m 0.2 L, m 0.2 Cansumables Consumables	1 1	Table B)		TENANCE	al, days ables, ko	CHANGES: Inte	ERATIONS/Sea for each of six
	Temperature, de Heat Rejection,	EQUIPMENT PHYS	CREU REQUIREMENTS	Skilla (See Te	N OID	RUICING/MAIN	SERVICE Interval, days Returnables, kg	NFIGURATION	Size is unit size for o

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2503	ELEMENT NAME	SPACE COMPONE	NT LIFETIME	
ACCOMODATION: MATT				
1. STATION ACTIVATION (E.G.	, SET-UP/ASSEMBLY	/ATTACHMENT AND	CHECKOUT)	
DATE(S) 1990 INT	. HR\$	EVA HRS	EVA CREW_	
☐ NOT APPLICABLE				
2. SERVICE (E.G., REPLENISH/	RESUPPLY)			
INTERVAL DAYS				
TMS/OTV REQUIRED		STATION H	RS PER SERVICE _	
NOT APPLICABLE		EVA HRS PE	R SERVICE _	
		EVA CREWS	SIZE _	
3. STATION OPERATIONAL SU	PPORT (AVG. TIME	FOR MONITOR, INSP	ECT, ETC.)	
HRS PER DAY (II	NTERNAL)			
HRS PER DAY (E	VA)			
☐ NOT APPLICABLE				
4. RECONFIGURATION				
INTERVAL 180 DAYS	TOTAL RECON	igs. <u>19</u>		
TMS/OTV REQUIRED		STATION HR	S PER RECONFIG.	
NOT APPLICABLE		EVA HRS PE	R RECONFIG	8
		EVA CREWS	IZE _	1
5. DEACTIVATION/REMOVAL	•			
DATE(S)INT.	HRS	EVA HRS	EVA CREW	
NOT APPLICABLE				
6. NOTES (BRIEFLY DESCRIBE	TASKS IN 1 THROU	GH 5 ABOVE)		
 Set up part of s Monitoring and r 2 EVA's per year Set-up/removal part 	ecording over 10 year	period uration charge		

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Code: GDCD 2503

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Space Component Lifetime Technology

Reference Documents:

 Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq., 14-15 September 1982.

Narrative:

Payload element objective, description, accommodation mode, and duration taken from Ref 1.

Number of components and all other data derived.

Code: GDCD 2503

PAYLOAD ELEMENT SYNTHESIS

SPACE COMPONENT LIFETIME TECHNOLOGY

I. Mission Objective

To provide a technology base for the development of diverse hardware components for which a multi-year operational lifetime under space conditions is specified.

II. Mission Description

The propsed mission would characterise the performance lifetime of critical components selected form varied space technologies. Components requiring evaluation in the space environment include primary propulsion systems; solar cell and chemical battery power units; space qualified solid film lubricants; laser and conventional spin gyros; and microwave amplifier cathodes.

III. Benefit

The proposed technology evaluation of spaceborne power units, propulsion systems, and navigational devices will have direct applicability to NASA deep planetary missions. In general, the component lifetime demonstrations achieved through the proposed Mission would increase the probability for sucess of advanced space projects.

IV. Justification

It is clear from the definition of the Mission objectives that the requiste component technology investigation can only occur on a long duration space laboratory. For proper solar cell technology evaluation, both the orbital solar illumination and high energy particle flux are required. In additon to conversion efficiency, a major technological tradeoff between silicon and gallium arsnide solar cells is the ability to withstand radiation damage. In order to perform the in situ annealing and repair of degraded solar cells, a manned presence is required.

V. <u>Mission Requirements and Capabilities</u>

- A) Orbital Parameters- The Mission orbit should insure the requisite photon and high energy particle flux.
- B) Mass, Volume, and Operational Envelope- TBD
- C) Power- Instrument specfic.

Code: GDCD 2503

PAYLOAD ELEMENT SYNTHESIS

- D) Thermal Control- TBD
- E) Attitude, Stabilization- Verification and measurement of

gryoscopic performance requires high space station angular stability.

- F) Viewing See comment A) above.
- G) Environmental Constraints- none.
- H.I) Data Management, Communications, Crew Lifetime- TBD
- J') Operations Schedule, Maintenance, Lifetime- The components to be tested have nominal space lifetimes between five and ten years.

VI. Space Station vs. Free Flyer

Although a detailed trade-off analysis is required it should be pointed out that the critical Mission specifications are characteristic of anticipated space station performance.

	Page 1 of 3
PAYLOAD ELEMENT NAME CODE 2 5 0 4	TVPE
0 6 3 0	OScience &
	Applications (non-commercial)
Addrass P.O. Box 85357 San Diego, CA 92138	Commercia!
Telephone (619) 277-8900, Ext. 3778/2130	X Technology Development
STATUS	Operations
	Type Number 15
First flight, yr 1992 No. of flights 1 30 Duration of Flight, days 30	Importance of the Space Station to
	this Elomont
To develop procedures, software, and hardware for maneuvering payloads at the Space Staion and interfacing with OTV/TMS systems, in order to be ready for actual missions to follow.	1 - low value but could use 10 - vital
	Scale 1 - 10 9
DESCRIPTION Sample or mocked-up payloads with planned interfaces will be delivered to the orbiting Space Statioan by the Shuttle. Typical maneuvers such as berthing at the station mating to an OTV, and deploying in orbit, will be performed. EVA and RMS/TMS operations will both be investigated. Information from the experiments will be fed back into the design process, impacting the configuration of interfaces and handling equipment.	ices will be delivered to the is berthing at the station and RMS/TMS operations will ed back into the design equipment.

m	ORIG OF F	INAL PAGE 19		
CODE 6 0 C 0 2 5 0 4 Page 2 of	INTATION Institut (Jitter)arc sec/sec	rating 300 Power, W Duration, hrs/day and by Erequency, Hz	MUNICATIONS ng requirements;	Data Types: Analog XDigital XHrs/Day 2 Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

ORIGINAL PAGE 19 OF POOR QUALITY

CODE	6 D C D 2 5 0 4 Page 3 26	r
		_ _
= . ب		
Heat Rejection, w operational min max		
S I Remote		_
	Stowed	
kg		
CREW REQUIREMENTS	MBX	
Crew Size 2 Task Assignment		
i l		
LEUEL 3 2		
Hrs/Day 4 4		
EUA X YES NO Reason Payload Handling Hrs/EUA	09 8 0.	
Cons		
CONFIGURATION CHANGESTINGERING day		
c d	_	
ONS	J	
EVA is part of payload element operation. 2 Hr/Day.		
the second state of the se		

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2504 ELEMENT NAME OTV PAYLOAD HANDLING
ACCOMODATION: ATTACHED FREE FLYER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)
DATE(S) 1992 INT. HRS EVA HRS EVA CREW
☐ NOT APPLICABLE
2. SERVICE (E.G., REPLENISH/RESUPPLY)
INTERVAL DAYS TOTAL SERVICES
☐ TMS/OTV REQUIRED STATION HRS PER SERVICE
■ NOT APPLICABLE EVA HRS PER SERVICE
EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)
E HRS PER DAY (INTERNAL) for 30 days
2 HRS PER DAY (EVA) for 30 days
□ NOT APPLICABLE
4. RECONFIGURATION
INTERVAL DAYS TOTAL RECONFIGS.
☐ TMS/GTV REQUIRED STATION HRS PER RECONFIG.
☑ NOT APPLICABLE EVA HRS PER RECONFIG.
EVA CREW SIZE
5. DEACTIVATION/REMOVAL
DATE(S) 1992 INT. HRS EVA HRS EVA CREW
□ NOT APPLICABLE
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)
1. Original set up part of station operations
3. Inside/outside activity for 30 day period5. Removal part of station operation

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2504

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: OTV Payload Handling

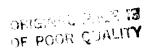
Reference Documents:

- 1. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hg., 14-15 September 1982.
- Definition of Technology Development Mission for Early Space Station, Orbit Transfer Vehicle Servicing, General Dynamics Convair Division, NAS 8-35039.

Narrative:

This payload element is based in part on Ref 1 entitled "OTV Servicing Technology", and on data developed in Ref 2.

The service enclosure is equipped with a docking boom that contains a motorized carriage at one end and a RMS at the opposite end. Prior to attaching the payload, the service enclosure is moved toward the Space Station and the simulated OTV is rotated 90 degrees. The simulated payload is retrieved from the Space Station holding fixture by moving the docking boom along the length of the service enclosure and attaching the docking boom RMS to the payload. The simulated payload is then mated to the OTV using the dock boom and RMS.

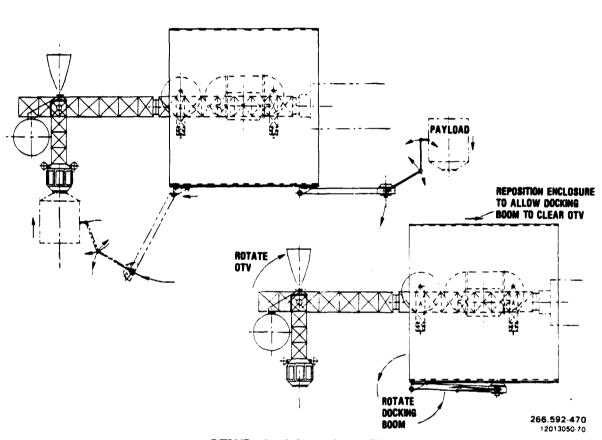


GDC-ASP-83-002

Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2504

PAYLOAD ELEMENT SYNTHESIS



.OTV/Payload Operations TDM

	Page 1 of 3
PAYLOAD ELEMENT NAME Payload Servicing and Repair	_
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division Address P. D. Roy 85357	Applications (non-commercial)
San Diego, CA 92138	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	X Tachnology Development
STATUS	Oberations
,	Type Number 15
First flight, yr 1992 No. of flights 1 Duration of Flight, days 90	(see Table A) Importance of the Space Station to
rres, in o	
	10 - vital Scale 1 - 10
A sample "servicing module" comprising typical preproduction electrical panels, fluid connections, latching devices, couplings, and other interfaces associated with servicing functions will be deployed externally at the station. Astronauts will utilize this equipment to perform simulated service/repair/reconfiguration functions in the space environment. Information feedback will influence the design of pertinent equipment.	ctrical panels, fluid ssociated with servicing s will utilize this equipment the space environment. In-

ORIGINAL MASSING OF POOR QUALITY

m		1 1	1		
6 D C D 2 5 0 5 Page 2 of 3			Continuous	Frequency (MHZ)	MHZ)
CODE	iges, km LEO Tolerais + Ephemeris Acc	TION Inertial Solar Earth Known Lyarc sec Field of view, deg	Power, W Duration, hrs/day	Required Other (KBS)	Analog Digital Hrs/Day Voice (Hrs/Day) 4
	STI	POINTING/ORIENTATION Usew direction Truth Sites (if known Pointing accuracy, arc Pointing Stability (J		ATA/COMMUNICATION Onitoring require None Encryption/Dec	Data Types: Analo Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBI Data Dump Frequency (Recording Rate (KBPS)

ORIGINAL PAGE 19 OF POOR QUALITY

•	າ	OF POOR Q						
CODE 6.0.0.2505	re, deg C operational min non-operational min ction, w operational min non-operational min	PMENT PHYSICAL CHARACTERISTICS tion: Internal External Remote pment ID/Function Pressurized Vinnessurized L,m 9 U,m 4.5 H,m Launch mass, kg Consumables Types Acceleration sensitivity, g min	Crow Size 1 Task Assignment Skills (See Table B) SKILL 7	EUA IXIVES UNO Rouson Payload Operations Hrs/EUA 200	TENAN Al, d	EsiInterval, day Deliverables, kg	.2 Hr/Day.	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2505	ELEMENT NAME _	PAYLOAD	SERVICING AND	REPAIR
ACCOMODATION: 🗷 ATTA	CHED	FLYER	OTV OPS	
1. STATION ACTIVATION (E.G.,	SET-UP/ASSEMBLY/	ATTACHMENT	AND CHECKOUT)	
DATE(S) 1992 INT.	HRS	EVA HRS	EVA CREW	
☐ NOT APPLICABLE				
2. SERVICE (E.G., REPLENISH/F	IESUPPLY)			
INTERVAL DAYS	TOTAL SERVICES			
TMS/OTV REQUIRED_		STATIO	N HRS PER SERVICE	
■ NOT APPLICABLE _		EVA HR	S PER SERVICE	
		EVA CR	EW SIZE	
3. STATION OPERATIONAL SUF	PORT (AVG. TIME F	OR MONITOR, I	INSPECT, ETC.)	
1 HRS PER DAY (IN	TERNAL) for 9	0 days		
2.2 HRS PER DAY (EV	(A) for 9	0 days (20	00 total)	
☐ NOT APPLICABLE		•		
4. RECONFIGURATION				
INTERVAL DAYS	TOTAL RECONFI	GS.		
☐ TMS/OTV REQUIRED			- I HRS PER RECONFIG	3
NOT APPLICABLE			PER RECONFIG.	
		EVA CRE	W SIZE	
E DEACTIVATION/DEMOVAL				
5. DEACTIVATION/REMOVAL				
DATE(S) 1992 INT.	HRS E	VA HRS	EVA CREW _	
NOT APPLICABLE				
6. NOTES (BRIEFLY DESCRIBE	TASKS IN 1 THROUG	H 5 ABOVE)		

- Original set ups part of station operations
 Inside/outside activity for 90 day period
 Removal part of station operations

Page 1 of 1 Volume II, Book 1 Appendix I

Code: GDCD 2505

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Playload Servicing and Repair

Reference Documents:

- 1. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq, 14-15 September 1982
- 2. Definition Of Technology Development Mission For Early Space Station, Orbit Transfer Vehicle Servicing, General Dynamics Convair Division, NAS 8-35-39

Narrative:

This payload element is based in part on Ref 1 entitled ""Satellite Servicing Technology", and on data derived in Ref 2.

ORIGINAL PAINTS

	Applications (non-commercial)	Commercial Technology	rations 15	(see Table A) Importance of the Space Station to	pr ¢	Scale 1 - 10 9	ace Station by the the areas of fluid and propellant transfer. eas of propellant	
G 0 C 0 2 5 0 6	LO		Planned Candidate			28	and receiver tank will be delivered to the Space Station by the transfer, investigations will be performed in the areas of flui:hilldown of transfer lines and receiver tank, and propellant tr. je, investigations will be performed in the areas of propellant coring, insulation, meteoroid protection, propellant acquisition ation, and venting.	
Propellant Transfer and Storage	CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division Addrass P.O. Box 85357	San Diego, CA 92138 Telephone (619) 277-8900, Ext. 3778/2130	rational	ght, yr 1991 ights 1 of Flight, days			DESCRIPTION A storage and receiver tank will be delivered to the Space Station by the Shuttle. For propellant transfer, investigations will be performed in the areas of fluid interface connections, chilldown of transfer lines and receiver tank, and propellant transfer. For long duration storage, investigations will be performed in the areas of propellant condition/quantity/monitoring, insulation, meteoroid protection, propellant acquisition, stratification/pressurization, and venting.	

ORIGINAL PAGE 19 OF POOR QUALITY

111
On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS) Downlink Frequency (MHZ)
:

ORIGINAL PAUL TO OF POOR QUALITY

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5 0 6	Page 3 of	Stowed Deployed Max max eq.	
CODE	A B B X A B B X A B B B X A B B B X A B B B X A B B B A B B A B B A B B A B B A B B A B B A B B B A B	e la se	
	lonal min conal min conal min	rnal Remotes surized Unpressurized Unpressurized Unpressurized Unpressuring Assignment Task As	
	B 3 9	Internal Sexternal Function Pressuri L, m 8.5 W, Launch mass, kg Consumables Type Acceleration sensole B) SKILL HEVEL Hrs/Day \[\text{NO} \text{Reason} \] NTENANCE Val, days As Deliverables, day Deliverables, day Deliverables, day Deliverables, day Deliverables, day Deliverables, day Deliverables, day Deliverables, Denits for tank support because of the context	
	THERMAL []Activa Temperature, deg Heat Rejection, w	ID, ID, ID, ID, ID, ID, ID, ID, ID, ID,	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE2	506 ELEMENT NAME	OTV PROPELLANT	TRANSFER A	ND STORAGE
ACCOMODATION:	X ATTACHED	E FLYER OTV	OPS	
	TION (E.G., SET-UP/ASSEMBL'			
☐ NOT APPLIC	ABLE			
2. SERVICE (E.G., RE	EPLENISH/RESUPPLY)			
	_ DAYS TOTAL SERVICE			
TMS/OTV R	EQUIRED	STATION HRS	PER SF3VICE	
☒ NOT APPLIC	ABLE	EVA HRS PER	SERVICE	
		EVA CREW SIZ	E	
1 HRS PI HRS PI HRS PI NOT APPLIC	ON _ DAYS TOTAL RECON	FIGS	PER RECONFIG	
☑ NOT APPLIC	ABLE	EVA HRS PER F	ECONFIG.	
•		EVA CREW SIZI	<u></u>	
5. DEACTIVATION/F	REMOVAL			
DATE(S) 1991	INT. HRS	EVA HRS	EVA CREW	
☐ NOT APPLIC	ABLE			
6. NOTES (BRIEFLY	DESCRIBE TASKS IN 1 THRO	JGH 5 ABOVE)		
 and 5. are This is a 	e considered station 30 day mission	operations		

Page 1 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2506

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: OTV Propellant Transfer and Storage

Reference Documents:

- 1. Technology Development Mission, Space Station NAAO Study Orientation Meeting, NASA Hq., 14-15 September 1982
- 2. Definition of Technology Development Missions for Early Space Station, Orbit Transfer Vehicle Servicing, General Dynamics Convair Division, NAS 8-35039

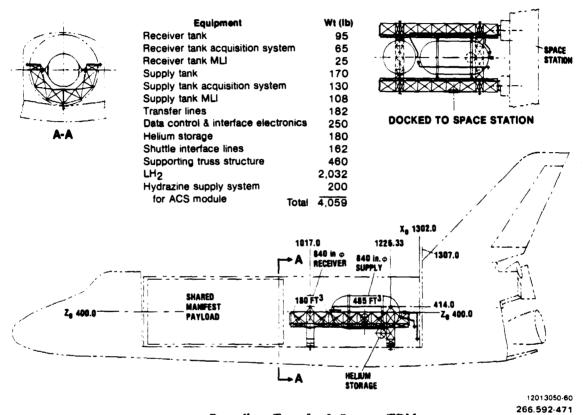
Narrative:

This payload element is based in part on Ref 1 entitled OTV Servicing Technology and on data developed in Ref 2.

The propellant transfer module consists of one spherical receiver tank, one cylindrical supply tank with spherical bulkheads, an open truss support structure, transfer lines, shuttle interface plumbing (fill, drain, vent, dump), and a helium supply system for dump and transfer. Each tank has an acquisition system and multi-layer insulation. Both tanks are supported from the truss structure which in turn interfaces with the Shuttle longeron and keel fittings. The support truss also has berthing systems on the forward and aft ends and on one side. The aft end attaches to the space station, the forward end attaches to beams delivered on a subsequent flight and the side interfaces with the propellant conservation (liquefaction) module. The transfer module also includes data control and interface electronics and a hydrazine system for filling and discharging the ACS bottles.

Page 2 of 2 Volume II, Book 1 Appendix I

Code: GDCD 2506



Propellant Transfer & Storage TDM

		10 7 101
PAYLOAD ELEMENT NAME OTV Propellant Liquefaction	G D C D 2 5 0 7	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division		Applications (non-commercial)
San Diego		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		X Tachnology
STATUS		2 KBER O BASA
nal	po	Operations
	date	15 15
1001		Tagman ada
		_ [
Duration of Flight, days 30		Importance of the
OBJECTIVE		this Eloment
	ify cryogenic	20 20 20 20 20 20 20 20 20 20 20 20 20 2
propellant boil-off from long duration storage tanks.		could use
-		10 - vital
		Scale 1 - 10 9
i	cle refrigeration sy	stem will be delivered to
the space station by the shuttle. Inls system and investigations carried out in reliquifyir	n will be attached to ng the boil-off prope	the Snuttie. Inis system Will be attached to the long term storage tanks arried out in reliquifying the boil-off propellant from the storage tanks.
The efficiency of the system propellant quantity reliquified, power required, and reliability of the system will be investigated.	tity reliquified, pow	wer required, and reliability

OPIGINAL PAGE 19 OF POOR QUALITY

CODE 6.0.0.2.5.0.7 Page 2 of 3
ORBIT CHARACTERISTICS Apogee, km LEO Tolerance + Inclination, deg Any Tolerance + Nodal Angle, deg Ephemeris Accuracy, m Escane do Recuired.m/s
POINTING/ORIENTATION Usew direction
ing accuracing Stabilial Restrict
× ⊠ AC
Standby Peak Ooltage, U
UNICATIONS grequirements; \timesitime \squit ption/Decryption Require Req.:Command Rate (Ki and Data Processing Req iption
Data Types! Analog XDigital XHrs/Day 1 Film (Amount) Oolce (Hrs/Day) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

10 C - 10 C - 2 C - 7 C - 3 OL	0
THERMAL —Active —Passive Temperature, deg C operational minmax non-operational minmax Heat Rejection, w operational minmax	
EQUIPMENT PHYSICAL CHARACTERISTICS Location: Ordernal External Remote Equipment ID/Function Pressurized Unpressurized L,m 3.5 U,m 2.0 H,m 2.0 Deployed Launch mass, kg Consumables Types Acceleration sensitivity, g min max	<u> </u>
Task Assignme	
Hrs/Day 1	T
EUA LIYES XINO Rakson	П
SERVICING/MAINTENANCE SERVICE:Interval, days Man Monra	
day tos, kg	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2507 ELEMENT NAME	OTV PROPELLANT LIQUEFACTION
ACCOMODATION: 🔼 ATTACHED 🗀 FRE	E FLYER
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY	
DATE(S) 1991 INT. HRS	EVA HRS EVA CREW
NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	
INTERVAL DAYS TOTAL SERVICE	S
TMS/OTV REQUIRED	STATION HRS PER SERVICE
☑ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME	FOR MONITOR, INSPECT, ETC.)
1 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONI	FIGS
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
	EVA HRS EVA CREW
□ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROU	GH 5 ABOVE)
 and 5. are considered station of This is a 30 day mission. 	pperations

Page 1 of 5 Volume II, Book 1 Appendix I

Code: GDCD 2507

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: OTV Propellant Liquefaction

Reference Documents:

- 1. Technology Development Mission, Space Station NAAO Study Orientation Meeting, NASA Hq., 14-15 September 1982
- 2. Definition of Technology Development Missions for Early Space Station, Orbit Transfer Vehicle Servicing, General Dynamics Convair Division, NAS 8-35039
- 3. Investigation of Gas Liquefiers For Space Operation, AF Aero-Propulsion Laboratory Aeronautical Syst. Div., Airforce Syst. Command Wright Patterson AFB, Ohio. Prepared by Malaker Lab. Inc. High Bridge, N,J., J.G. Daunt et al. 1968
- 4. Handbook of External Refrigeration Syst. for Long Term Aero Storage, LMSC Sunnyvale, CA 1971.

Narrative:

This payload element is based in part on Ref 1 entitled OTV Servicing Technology and on data developed in Ref 2. Refrigeration requirements are derived based on Ref 3 and 4.

The propellant liquefaction module is a multi-sided box-type package containing refrigeration equipment, electrical systems, instrumentation, controls, and disconnect systems for attaching to the transfer module. The module also has a radiator package strapped on the aft end, which is attached to the Space Station structure. The Space Station incorporates plumbing between the radiator attachment and the transfer module.

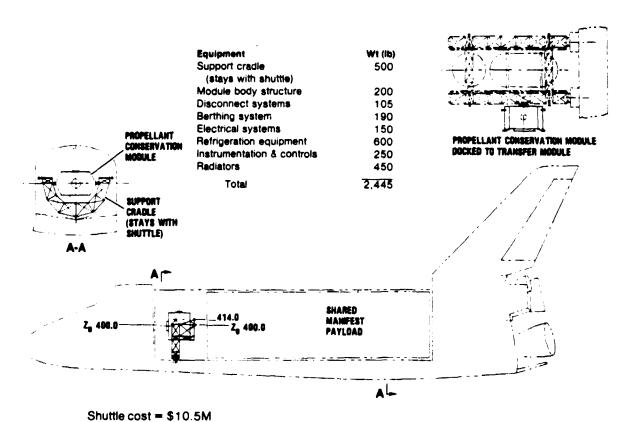
The propellant liquefaction module is supported from a truss cradle that in turn interfaces with the Shuttle keel and longeron fittings. The module is located at the forward end of the shuttle payload bay, which is within the reach envelope of the shuttle RMS.

GDC-ASP-83-002

Page 2 of 5 Volume II, Book 1 Appendix I

Code: GDCD 2507

PAYLOAD ELEMENT SYNTHESIS



12013050-61 266.592-472

Propellant Reliquefaction TDM

Page 3 of 5 Volume II, Book 1 Appendix I

Code: @DCD 2507

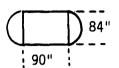
PAYLOAD ELEMENT SYNTHESIS

Space Heater Transfer To The Supply And Receiver Tanks

SUPPLY TANK

VOLUME: 485 ft3

WEIGHT OF LH2 (5% ULLAGE): 2027 LB



SURFACE:

Surface of sphere = $4\pi r^2 - 4\pi \ 3.5^2 = 153.86 \ \text{ft}^2$ Surface of straight section = $D\pi L = 164.85$

318.71 ft²

HEAT LEAK
$$\frac{0.16 \text{ BTU } 318.71 \text{ ft}^2}{\text{hr ft}^2} = 51.0 \text{ hr}$$

HEAT FLUX = 0.16 BTU From experimental results using the 87" tank

BOIL OFF RATE = $\frac{51 \text{ BTU}}{\text{hr}} = \frac{1b}{192 \text{ BTU}} = 0.27 = \frac{1b}{\text{hr}} = 6.48 = \frac{1b}{\text{day}}$

LAYERS OF MLI = 45 Radiation Shields

RECEIVER TANK

VOLUME: 180 ft3

(84")

WEIGHT OF LH2 (5% ULLAGE): 752 1b

SURFACE: 153.86 ft²

BTU

HEAT LEAK: (0.16) 153.86 = 24.6

hr

BOIL OFF:
$$\frac{24.6}{192} = 013 \frac{1b}{hr} = 3.12 \frac{1b}{day}$$

Code: GDCD 2507

PAYLOAD ELEMENT SYNTHESIS

Refrigeration Requirements (Stirling or Brayton Cycle)

WATTS OF REFRIGERATION NEEDED FOR RELIQUEFACTION OF 1 LB/DAY OF HYDROGEN = 2.37 WATTS (Ref 3).

COOLING NEEDED TO RELIQUEFY THE BOILOFF FROM THE SUPPLY & RECEIVER TANK:

0.27 lb/hr + 0.13 lb/hr = 0.40 lb/hr = 9.6 lb/day

THE COOLING NEEDED TO RELIQUEFY 0.4 1b/hr:

$$(9.6 \text{ 1b/day}) 2.37 \frac{\text{W}}{\text{1b/day}} = 22.75\text{W}$$

RELIQUEFICATION RATE IS
$$\frac{22.75W-hr}{0.4 \text{ lb}} = 56.88 \frac{W-hr}{\text{lb}}$$

NOMINAL COOLING DESIRED:

SUPPLY TANK + RECEIVER TANK

$$51.0 \frac{BTU}{hr} + 24.6 \frac{BTU}{hr} = \frac{BTU}{Tb}$$

IN WATTS = $75.6 \times 0.2930 = 24W$

DESIGN COOLING 10% MARGIN = 22W

NOMINAL COOLING TEMP. 20K

COOLING RANGE 17-23K

COEF OF PERFORMANCE COP =
$$\frac{Q \text{ REFR.}}{Q \text{ INPUT}} = \frac{Tc}{T_h - T_c \text{ carnot}}$$

ASSUME MAX TEMP $T_h = 300K$ $T_C = 20K$

$$COP = \frac{20}{300-20} = 0.071$$

THE POWER INPUT FOR RELIQUEFACTION = $\frac{24}{0.071}$ = 338W

of 5 Page 5 Volume II, Book 1 Appendix I

Code: GDCD 2507

PAYLOAD ELEMENT SYNTHESIS

SPEC. WEIGHT = 2 LB/WATT (Ref 4)
TOTAL REFR. WEIGHT = 676 lb
SPEC. VOLUME: 70 m³/WATT
REFRIG. VOLUME: 23660 in³/WATT = 13.7 ft³

WASTE HEAT RADIATOR: ≈ 200 ft3

POWER SUPPLY: PHOTOVOLTAIC AREA ON SPACE STATION OR ERECTABLE PANEL TYPE

CONFIGURATION

COOL DOWN OF THE REFRIGERATOR

Cool down time of a refrigerator, where the mass is relatively high and where intermittent operation is desirable, can be an important consideration. For the intermittant operation case all heat exchanger elements and fluid cooling systems must be cooled down to operating conditions prior to efficient propellant refrigeration.

COEFFICIENT OF PERFORMANCE (COP)

- 1. The COP decreases substantially as the unit becomes smaller - higher heat leaks, components more difficult to fabricate - unfavorable area to volume ratios - fictional losses higher.
- 2. The COP is so low because there are so many components involved - heat source - heat sink, mechanical refrigeration and mechanical work source. Refrigerator has a compressor, expander, and motor. These components contribute to the COP.

		Page 1 of
PAYLOAD ELEMENT NAME OTV Docking and Berthing	CODE G D C D 2 5 0 8	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Name General Dynamics Convair Division		Applications (non-commercial)
San Diego, CA 92138		Commercial
Telephone (619) 277-8900, Ext. 3778/2130		X Technology Development
nal	Planned	Operations
	Opportunity	Type Number 15
First flight, yr 1991 No. of flights 1 Duration of Flight, days 30 OBJECTIVE		(see Table A) Importance of the Space Station to this Element
To develop procedures, software and hardware for docking and berthing an OTV to a Space Station.	re for docking and	1 - low value but could use 10 - vital
		Scale 1 - 10 9
DESCRIPTION Deliver a modified TMS, a simulated OTV and docking, berthing and maintenance equipment to the Space Station by means of the Shuttle. Perform docking operations with a modified TMS and docking mechanisms to simulate OTV characteristics in the areas of stability and control, maneuverability, communications, connecting up, and monitoring and controls. Perform berthing system operations to verify equipment and procedures in the areas of alignment sensors, contact sensors, coupling and access, and manipulators. Automated docking and berthing capability with manned backup should be investigated and cerified.	mulated OTV and docking the Shuttle. Perform ulate OTV characteristins, connecting up, and equipment and proceduress, and manipulators.	r a modified TMS, a simulated OTV and docking, berthing and maintenance ce Station by means of the Shuttle. Perform docking operations with a king mechanisms to simulate OTV characteristics in the areas of stability rability, communications, connecting up, and monitoring and controls. Peroperations to verify equipment and procedures in the areas of alignment sors, coupling and access, and manipulators. Automated docking and berthmanned backup should be investigated and cerified.

of 3			•		
0 8 Page 2 of	•		Continuous	(ZHW)	2
CODE 6 D C D 2 5 0 8	Tolerance + Tolerance + Ephemeris Accuracy, m	Earth Field of view, deg	Duration, hrs/day	Other Frequency (MHZ)	Voice (Hrs/Day) Other Downlink Frequency (MHZ)
	Perigee, km LEO Any	TION Inertial Solar moun) Jarc sec	Obc Power, W 300 - 500 Frequen	oments: Realtime Of cryption Requir ommand Rate (KI Processing Req	☐Analog ⊠Digite Day) ago (MBIT) quency (Per Orbit) c (KBPS)
	ORBIT CHARACTERIS Apogee, km LEO Inclination, deg Nodal Angle, deg	OINTING/ORIENTA flow direction ruth Sites (If ointing sceurac ointing Stabili	OUER Ac Operating Standby Peak	MUNICATI ng requi Hption/Di nk Req.:	Data Types! Film (Amount) Live TV (Hrs/ On-Board Stor Data Dump Fre

CODE 6.0.0.0.2.5.0.8 Page 3	3 of 3
EQUIPMENT PHYSICAL CHARACTERISTICS Location:	
Task Assignment	
Skills (See Table B) SKILL 7 LEVEL 3	
Hrs/Day	
EUA TYES XNO Reuson Hrs/EUA	
SERVICING/MAINTENANCE SERVICE:Interval, days Consumables, kg	
NGESIInterval, day	
lons	
Power and data interface. Control station for docking. Docking and berthing for IMS when not used as simulated OTV.)t

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GDCD CODE 2508 ELEMENT NAME	OTV DOCKING AND BERTHING
ACCOMODATION: MATTACHED - FREE	FLYER OTV OPS
1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY	/ATTACHMENT AND CHECKOUT)
DATE(S) 1991 INT. HRS	EVA HRS EVA CREW
☐ NOT APPLICABLE	
2. SERVICE (E.G., REPLENISH/RESUPPLY)	·
INTERVAL DAYS TOTAL SERVICES	B
TMS/OTV REQUIRED	STATION HRS PER SERVICE
■ NOT APPLICABLE	EVA HRS PER SERVICE
	EVA CREW SIZE
3. STATION OPERATIONAL SUPPORT (AVG. TIME (FOR MONITOR, INSPECT, ETC.)
2 HRS PER DAY (INTERNAL)	
HRS PER DAY (EVA)	
☐ NOT APPLICABLE	
4. RECONFIGURATION	
INTERVAL DAYS TOTAL RECONF	rigs
TMS/OTV REQUIRED	STATION HRS PER RECONFIG.
☑ NOT APPLICABLE	EVA HRS PER RECONFIG.
	EVA CREW SIZE
5. DEACTIVATION/REMOVAL	
DATE(S) 1991 INT. HRS	EVA HRS EVA CREW
☐ NOT APPLICABLE	
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROU	GH 5 ABOVE)
 and 5. are considered station This is a 30 day mission 	operations.

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Code: GDCD 2508

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: OTV Docking & Berthing

Reference Documents:

- Technology Development Mission, Space Station NAAO Study Orientation Meeting, NASA Hq., 14-15 September 1982
- Definition of Technology Development Missions for Early Space Station, Orbit Transfer, Vehicle Servicing, General Dyramics Convair Division, NAS 8-35039

Narrative:

This payload element is based in part on Ref 1 entitled OTV Servicing Technology and data developed in Ref 2.

The simulated OTV and two truss frames are supported in the Shuttle payload bay. The OTV is attached to the two truss frames by means of berthing arms and the entire package (frames & OTV) is deployed from the shuttle and attached to the propellant transfer module. The truss frames also have an open "cherry picker" type device mounted on powered carriages for retraining the astronauts.

The modules shown can be removed from the simulated OTV for maintenance Technology Development Mission. The berthing interface is at the aft end of the core module.

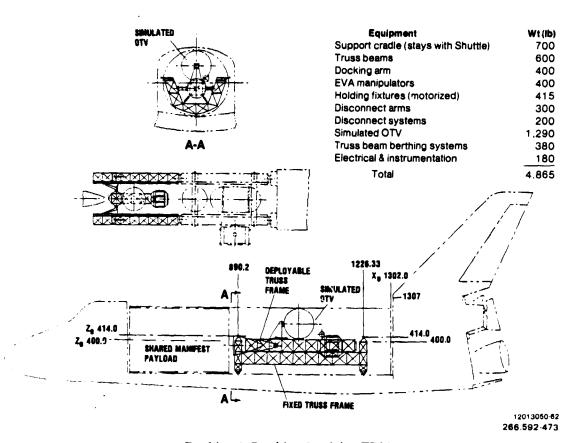
The module sizes were selected to be representative of actual sizes for an OTV in order to develop the capability to handle this type of equipment in space.

The berthing enclosure is positioned at the end of the truss beams away from the space station and the docking boom is rotated 90 degrees to the berthing enclosure. This provides a docking target removed from adjacent structures. Docking tests are performed using a TMS equipped with an adapter. The simulated OTV is positioned in the berthing port and will be used for the berthing tests.

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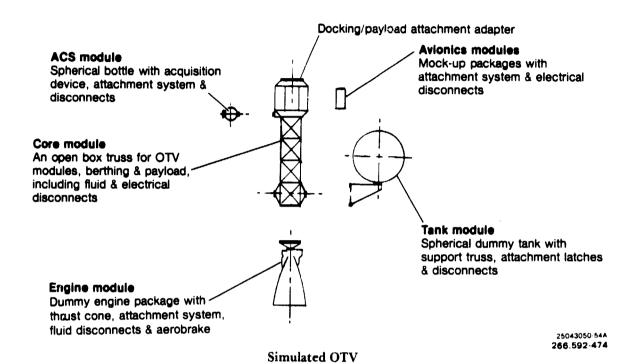
Docking & Berthing Servicing TDM

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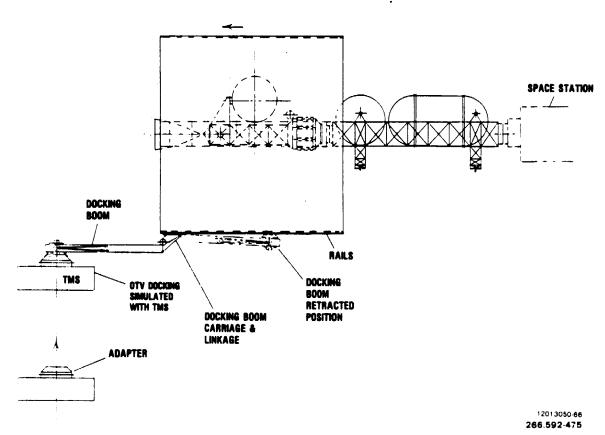


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Code: GDCD 2508



Docking TDM with Modified TMS

CODE			Page 1 of
	ELEMENT Lenance	CODE 6 0 C 0 2 5 0 9	
	ACT W. Hardy General		Science & Applications (non-commercial)
			Commercia!
	one (619) 27		X Technology Development
	Operational Approved	ned 1date	rations
cedut of the control	r 1992 1 ght, days		4 4 4 6 6 6 6
Deli Deli Deli Deli Deli Deli Deli Deli	OBJECTIVE To develop procedures, software and hardware a space-based OTV on a Space Station. Partic be placed on capability of crew to perform Edution maintenance tasks can be automated.	e for maintaining cular emphasis will EVA tasks and the	
Deliantenated transcript the mated re vise type of the mated re vise type of the tark			10
	Deli des t des t intena intena nated e vis	with berthing and mate will be at the statiliver a serivce enclose Station by the Shutthe capability of thuse and replace tasks. Handling, and remove ACS system, power gen	intenance equipment to the ion if the docking and berth-sure (collapsed in the cargo tle. Perform typical mainteneerwmen to perform EVA tasks The major functions to be inand replace. Remove and reseration system, main engine

CODE 6 D C D 2 5 0 9 Page 2 of 3	Tolerance + Ephemeris Accuracy, m	□Earth Field of view, deg	Duration, hrs/day Continuous Continuous Cu, Hz	Other Frequency (MHZ)	(Mrs/Day) 4 (Hrs/Day) Other 1
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Heat Rejection, w operational min		
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PHYSICAL CHARACTERISTICS		
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Crew Size 4 Task Assignment.		
Skills (See Table B) SKILL 7 7 7	7	
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s A	•	
kg Hours		
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Deliverables, kg	bles, kg	
SPECIAL CONSIDERATIONS/See Instructions		
	Onerations which	
are development of OTV maintenance capability. Crew size includes EVA personnel	onnel.	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

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GOCD CODE 2509	ELEMENT N	AME OTV M	<u>aintenance</u>	<u> </u>	
ACCOMODATION: §	ATTACHED	FREE FLYER	OTV OP	rs	
1. STATION ACTIVATIO	N (E.G., SET-UP/ASSE	MBLY/ATTACH	WENT AND CH	ECKOUT)	
DATE(S) 1992	INT. HRS	EVA HRS		EVA CREW_	
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TMS/OTV REQU	JIRED	S	FATION HRS PE	ER SERVICE _	
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3. STATION OPERATIO	NAL SUPPORT (AVG.	TIME FOR MONI	TOR, INSPECT	, ETC.)	
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4. RECONFIGURATION					
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TMS/OTV REQU	JIRED	ST	ATION HRS PE	R RECONFIG.	
☑ NOT APPLICAB	LE	EV	A HRS PER RE	CONFIG	
		EV	A CREW SIZE	_	
5. DEACTIVATION/REM	IOVAI				
DATE(S) 1992		EVA HRS	E	VA CREW	
5A7 E (67					
□ NOT APPLICAB	LE	•		_	
6. NOTES (BRIEFLY DE	SCRIBE TASKS IN 1 T	HROUGH 5 ABO	VE)		
 and 5. are co This is a 30 and tank cha 	onsidered stat O day mission; angeout on sim	inside/out	tside oper	ations are	e engine

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Code: GDCD 2509

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: OTV Maintenance

Reference Documents:

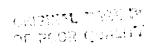
- 1. Technology Development Missions, space Station NAAO Study Orientation Meeting, NASA Hq., 14-15 September 1982.
- 2. Definition of Technology Development Missions for Early Space Station, Orbit Transfer Vehicle Servicing, General Dynamics Convair Division, NAS 8-35039.

Narrative:

This payload element is based in part on Ref 1 entitled OTV Servicing Technology and on data developed in Ref 2.

Two service examples are shown with an aerobrake attached to the simulated OTV. The first example is an engine module changeout. The engine module is equipped with an open truss cage, which attaches to the aerobrake through a series of structural disconnects. The change out is accomplished by latching the aerobrake to the truss beams; (view A-A); attaching the service enclosure RMS to a holding fixture on the space station. The reverse of this procedure is used to install the new engine module.

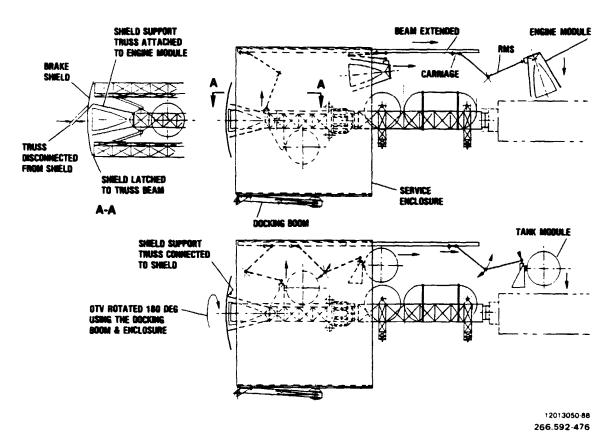
The second example shows a propellant tank module change out. This requires rotating the OTV 180 degrees so that the tank module is within reach of the RMS. This 180 degree rotation is accomplished using the enclosure and the docking boom.



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Maintenance TDM - Engine & Tank Change Out

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		Page 1 of
PAYLOAD ELEMENT NAME	CODE	TYPE
Tether Uynamıcs lechnology	6 0 0 0 0	Science 1
CONTACT W Hardy/J Peterson M7 21-9530		Applications
Nome General Dynamics Convair Division		(non-commercial)
P.0. Box		!
San Diego, CA 92138		Commercial
4 7 0000		X Technology
Telephone (619) 2//-8900, EXT. 3//0/2130		Development
STATUS		
nal	peut	Operations
Approved	Candidate Opportunity	Name of the second seco
1001	E .	
First flight, yr 1995		
٠		Importance of the
Duration of Fight, days		Space Station to
OBJECTIVE		this Eloment
Demonstrate feasibility of tether operations on a small scale	s on a small scale	1 . low calus but
before involving Shuttle orbiters and exter	and external tanks.	could use
		10 - oftal
		Scale 1 - 10 2.
DESCRIPTION		
Use two remotely piloted vehicles (RPVs) or	verated in coordination	loted vehicles (RPVs) operated in coordination with a tether cable to dem-
onstrate rendezvous and docking with free e	end of a tether cable, or from one orbit to an	and docking with free end of a tether cable, interchange orbits, spin-up ity and raise an elevator from one orbit to another using a tether cable.

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Page 2 of 3			gnonu!		
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GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 2510 ELEMENT NAME TETHER DYNAMICS TECHNOLOGY .

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ACCOMODATION: 🖫 ATTACHED 🗆	FREE FLYER	OTV OPS	
1. STATION ACTIVATION (E.G., SET-UP/ASSE	MBLY/ATTACHMENT	AND CHECKOUT)	
DATE(S) 1995 INT. HRS	EVA HRS	EVA CREW	
NOT APPLICABLE		 _	
2			
2. SERVICE (E.G., REPLENISH/RESUPPLY)	MICES		
INTERVAL DAYS TOTAL SER	•	Luge Den eerviee	
TMS/OTV REQUIRED		HRS PER SERVICE	
■ NOT APPLICABLE		S PER SERVICE	
	EVA CRI	EW SIZE	
3. STATION OPERATIONAL SUPPORT (AVG. 1	TIME FOR MONITOR, I	NSPECT, ETC.)	
3 HRS PER DAY (INTERNAL)			
HRS PER DAY (EVA)			
☐ NOT APPLICABLE			
4. RECONFIGURATION			
INTERVAL DAYS TOTAL RE	CONFIGS.	·-	
TMS/OTV REQUIRED	STATION	HRS PER RECONFIG.	
X NOT APPLICABLE	EVA HRS	PER RECONFIG.	
	EVA CRE	W SIZE	
5. DEACTIVATION/REMOVAL			
DATE(S) 1995 INT. HRS.	EVA HRS	EVA CREW	
—————————————————————————————————————			
6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 TI	HROUGH 5 ABOVE)		
1. and 5. Times for activation		tion are include	d in
experimental operat 3. Duration of experiment is retrieve subsatellites. F (RPV or TMS) are interconne	3 days for dep ree-flying exp	erimental subsat	ntrol, ellites

TOTAL EVA HRS __0

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Code: GDCD 2510

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Tether Dynamics Technology

Reference Documents:

- 1. "Utilization of the External Tanks of the Space Transportation System" Draft report (8 Oct. 1982) on a workshop held at the University of California, San Diego, La Jollla, CA, 23-27 August 1982. (See sections II and III and Appendix II.)
- 2. Columbo, Guiseppe, "A Straightforward Use of the Shuttle E.T." Enclosure to letter from Dr. Colombo to Professor J.R. Arnold, Space Institute, University of California, San Diego, La Jolla, Ca 92037, dated March 1982.
- 3. Gatland, Kenneth, "Manned Spacecraft" pp 174-179, Library of congress card 67-22617.
- 4. Bekey, Ivan, "Architectural Options for Space Stations in the Context of the Space Infrastructure". Office of Space Flight, NASA Headquarters, Washington. D.C.
- 5. Modi, V. J. and Chang-Fu, Geng, "On the Control of the Space Shuttle Based Tethered Systems," Acta Astronautica, Vol. 9, No. 6-7, pp 437-443, 1982.
- 6. Misra, A. K., and Modi, V. J., "Deployment and Retrieval of a Subsatellite Connected by a Tether to the Space Shuttle", AIAA/AAS Astrodynamics Conference, Danvers, Mass. Paper No. AIAA-80-1693 (1980).
- 7. Rupp, C. C, "A Tether Tension Control Law for Tethered Subsatellites Deployed Along Local Vertical" NASA TMX-64963 (1975)
- 8. Baker, W. P., et al. "Tethered Subsatellite Study", NASA TM X-73314 (1976)
- 9. Kulla, P., "Dynamics of Tethered Satellites," Proc. Symp. on Dynamics and Control of Non-Rigid Spacecraft. Frascate, Italy, pp 349-354 (1976)
- 10. Kallaghan, P. N., et al "Study of the Dynamics of a Tethered Satellite System (Skyhook)", Final Report, Contract NAS8-32199, Smithsonian Institution, Astro/Physical Observatory, Cambridge, Mass. (1978)
- 11. Modi, V. J. and Mistra, A. K., "On the Deployment Dynamics of Tether Connected Two-Body Systems", Acta Astronautica 6, 1183-1197 (1979)
- 12. Misra, A. K. and Modi, V. J., "A General Dynamical Model for the Space Shuttle Based Tethered Subsatellite System", Adv. Astronaut. Sci. 40, 537-557 (1979)

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PAYLOAD ELEMENT SYNTHESIS

- 13. Bainumm P.M. and Kumar, V. K., "Optimum Control of the Shuttle-Tethered-Subsatellite System", 30th Congress of the IAF, Munich, FRG. Paper No. 79-190 (1979)
- 14. Kane, Thomas R. and Levinson, David A., "Deployment of a Cable-Supported Payload From an Orbiting Spacecraft", J. Spacecraft, Vol. 14, No. 7, July 1977.
- 15. U.S. Patent 4,097,010 (27 June 1978), "Satellite Connected by Means of a Long Tether to a Powered Spacecraft", Guiseppe Colombo and Mario D. Grossi.
- 16. U.S. Patent 3, 532,298 (6 Oct. 1970), "Method for Deploying and Stabilizing Orbiting Structures", Charles T. Swet.
- 17. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq., 14-15 September 1982.

Narrative:

A tether system consists of two orbiting bodies connected by a flexible cable. The combined phenomena of gravity gradient and, centrifugal and Coriolis accelerations, make it possible to maneuver such a system in ways that may be useful in space operations. In particular, it is possible to interchange the positions of a pair of satellites, in high and low circular orbits, respectively, with little or no expenditure of propellant or mechanical energy. Angular momentum and energy of the system are conserved by values for the individual bodies are traded.

A tether scheme was patented by Swet in 1970 (Ref 16) and another by Colombo in 1978 (Ref 15). Since then, Dr. Colombo, and several others have studied the subject and made a number of specific proposals for operational applications - Refs 1 through 14. These range from bodies of a few 100 kg mass to the manned Shuttle Orbiter tethered to one or more of its external tanks (ETs). Cable lengths of 100 km have been suggested.

Preliminary tether tests were made during the Gemini program - see Ref 3 - and NASA has a contract, Tethered Subsatellite System (TSS), with Martin/Marietta and Aeritalia to devalop hardware for experiments from a Shuttle Orbiter scheduled to fly in about two years time. This will involve an approximately 500 kg subsatellite with a 20 km cable to study electrodynamic effects. A later experiment is planned with a 100 km tether that will tow the subsatellite in the upper atmosphere.

Code: GDCD 2510

PAYLOAD ELEMENT SYNTHESIS

Operations that involve one or more ETs tethered to the Orbiter are described in Ref l and 2. These include plans to have the Orbiter dock with the lower end of a tether, suspended from the tank in a high orbit, and then to rotate the system so as to interchange the orbits. Alternatively, the system could be stabilized with the Orbiter tethered immediately below the ET and an elevator could climb up or down the cables to carry propellant or payloads to higher orbit.

While such schemes do not violate any of the fundamental laws of physics, and behavior can in principle be predicted by analysis; feasibility should be demonstrated before attempting such operations with a manned Shuttle Orbiter. It is suggested that this could be done effectively and economically from an orbiting Space Station by making use of two Remotely Piloted Vehicles (RPVs) as outlined below.

B. TETHER MANEUVERING EXPERIMENT

Many tether systems have been proposed by Dr. colombo and others. Among them are schemes designed to accomplish the following tasks:

- a. Raise or lower the Shuttle Orbiter to a different orbit by interchanging it with an ET previously placed in the different orbit.
- b. Provide an elevator system that crawls up and down the cable between the Orbiter and ET.
- c. Provide artificial gravity by spinning up the tether system.

Feasibility must be demonstrated before applying such ideas to a manned Shuttle Orbiter. It is suggested that this could be done effectively and economically from an orbiting Space Station, making use of two RPVs as outlined in the following paragraphs.

Rendezvous and Dock

Before considering useful tasks it is important to assure ability to rendezvous and dock with a tether system. The first RPV (RPV1) will be launched from the Space Station and use its own propulsion, guidance and control system to achieve a circular orbit about 20 km higher (or lower). It will carry as payload a winch and tether cable. A docking and homing device will be lowered by the cable to a height about 1 km above the Space Station.

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PAYLOAD ELEMENT SYNTHESIS

The RPV/cable combination will have an orbital period that is slightly different from that of the Space Station, and on a subsequent orbit the second RPV (RPV2), carrying a docking device and an elevator, will be launched. This will then rendezvous and dock with the cable unit. Since the cable unit is not in free orbit by itself, it will be impossible for the RPV to achieve unpowered formation flight with the cable unit. Thus, the best that the chasing RPV can do is to make use of an orbit that approaches the cable unit and that momentarily provides zero relative velocity at one instant. In practice, RPV2 will have to use controlled thrusting to stationkeep with the cable unit while making the docking connection. This is the principal feature in which this type of docking differs from other free orbit docking events that have been accomplished previously.

In the attached sketches the tether system has been shown at an orbit above the Space Station and slightly ahead. For 20 km difference the tether will slip back about $1/3^\circ$ per orbit when station is at 200-300 km.

Interchange Orbits

When docking is complete, system should be observed for several orbits and rate of decay of oscillations (if any) should be noted. The interchange experiment can be initialized two different ways, one by "pumping" and the other by thrusting. Both should be tried to compare relative merits.

After residual oscillations from the docking transient have been observed sufficiently the cable should be partially retracted to increase angular velocity till the system "slips" over "top dead center". Cable "pumping" should then be initiated, with appropriate time phasing, to reduce oscillations.

When system has stabilized in the inverted position RPV2 should apply sufficient thrust to just "flip" the system over again, and when it has been reinverted a second thrust impulse will stabilize it again.

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Energy dissipation and propellant usage for the two procedures should be compared as well as relative operational advantages and problems. These in turn should be compared with propellant that would have been required to perform the same maneuver by means of Hohmann transfer.

For this experiment, each RPV must be designed (with ballast if necessary) so that its principal axis of maximum moment of inertia is perpendicular to the plane of rotation. In addition the cable attachment point to each module should be offset from the module centroid in the direction of the cable length by about 10 or 20% of the maximum radius of gyration of the module. These two requirements are needed to assure a stable dynamic system that will not require continuous active control during the maneuver.

Spin for Artificial Gravity

RPVI should apply an in-plane tangential thrust with sufficient magnitude to produce a definite spin rate. Radial acceleration (artificial gravity) should be measured as well as oscillations of the individual RPV modules relative to a reference frame that rotates smoothly with the tether system. Again it is mandatory that the principal axis of maximum moment of inertia of each module be perpendicular to the spin axis, and the cable attachment points be offset from each module centroid as required for the interchange experiment.

Spin should then be stopped with cable in the vertical position by means of a thrust impulse from one of the modules.

Payload Transfer Along the Cable (Elevator)

One of the RPV units, say RPV2, should carry a payload consisting of an "elevator" unit that is capable of climbing the cable. This unit must be designed to have its principal axis of maximum moment of inertia perpendicular to the orbital plane, and that of minimum moment of inertia in the direction of orbital motion. However, it should be supported from the cable at two points, which span its centroid. These requirements are needed to assure a stable dynamic system without continuous attitude control activities.

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PAYLOAD ELEMENT SYNTHESIS

When the tether system is stabilized vertically the elevator should start to climb along the cable. Oscillations of each module and the elevator should be monitored as well as the power required for the climb. The pitch, roll, and yaw attitude angles of the elevator should also be monitored.

As the elevator climbs the cable, the system moment of inertia will decrease and angular momentum will be conserved if no thrusting torques are applied.

The tether system will, therefore, start to pitch relative to the vertical as the elevator climbs. As the angular velocity increases, the resulting oscillatory amplitude can be predicted. When the prediction reaches a pre-arranged value, say 20 degrees, the climb rate of the elevator should be stopped and the system allowed to pass through its maximum amplitude angle, and when it reverses direction, the elevator should be started climbing again. At this time the gravity gradient torque will offset the effect of conservation of angular momentum thus reducing the oscillation. This procedure should be used on successive cycles of system oscillation to keep the system from spinning up. The phasing should be reversed when the elevator gets above the system centroid.

Retraction of Tether System

When the elevator has been secured to RPVI and the system stabilized vertically, RPVI should begin reeling in the cable. As in the case of the elevator, conservation of angular momentum will cause the system to spin up. A procedure similar to that used with the elevator should be used to negate the rotation. As the cable becomes short, difficulty may be encountered without application of rocket thrust torque. However, one of the major features of tether systems centers around the ability to maneuver with little or no expenditure of propellant. For this reason development of efficient and effective operational means of retracting the system is of high priority.

Return to Space Station

When the cable has been retracted fully, the two RPVs can be docked together and flown back to the Space Station as a single unit using conventional rocket transfer and control procedures. Alternatively the cable could be disconnected from RPV2 and each RPV flown back to the Space Station independently.

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PAYLOAD ELEMENT SYNTHESIS

OPERATIONAL TIMELINE

		Elapsed Time	
Operation	Duration	(Hrs)	$\star \Delta \theta$ (deg)
Unstow and countdown	6 Hrs		
Launch RPV1 and circularize in orbit 20-22 km above and 10-12 degrees ahead of Space Station	1 Orbit	6.0	
Launch RPV2 and circularize in orbit 1/2 km above and 10-12 degrees ahead of Space Station	1 Orbit	7.5	
Check orbits and lower tether from RPVI	1 Orbit	9.0	
RPV1 dock with end of cable	1 Orbit	10.5	11.0
Coast, observe oscillations and stability. Adjust amplitude by cylically changing cable length (pumping)	6 Orbits	12.0	10.7
Retract cable a small fraction of its length to increase angular velocity and interchange ends	2 Orbits	21.0	9.0
Re-extend cable and "pump" to stabilize after interchange	4 Orbits	24.0	8.5
Thrust with RPV2 to reinterchange positions	1 Orbit	29.9	7.3
Thrust with RPV2 to remove angular velocity and stabilize	2 Orbits	31.4	7.1
Thrust RPV2 to spin up. Coast and observe stability and artificial gravity while spinning	6 Orbits	34.4	6.5

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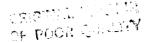
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PAYLOAD ELEMENT SYNTHESIS

OPERATIONAL TIMELINE (Continued)

		Elapsed Time	
Operation	Duration	(Hrs)	$\star \Delta heta$ (deg)
Thrust RPV2 to stop spin and stabilize	3 Orbits	43.4	4.8
Raise elevator from RPV2 to RPV1	4 Orbits	47.9	4.0
Dock elevator with RPV1 and stabilize	1 Orbit	53.9	2.8
Retract cable and dock RPVs together	6 Orbits	55.4	2.5
Return to Space Station and Dock	2 Orbits	64.4	0.8
Restow	6 Hrs	67.4	0.3
Terminate mission		73.4	

^{*} $\Delta \theta$ angle (degrees) by which tether leads station

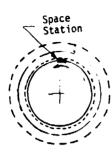


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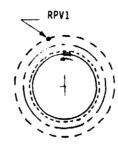
Page 9 of 10 Volume II, Book 1 Appendix I

Code: GDCD 2510 PAYLOAD E

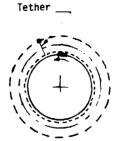




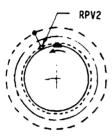
Launch RPV1



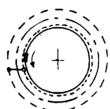
Modified Hohmann Transfer to point above & ahead of Suace Station



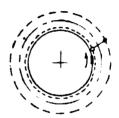
Lower Tether & Stabilize.
Launch RPV 2



Rendezvous & Dock with end of cable

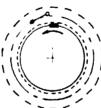


Coast & Observe
Oscillations and
stability. Adjust
amplitude by "pumping"
cable with appropriate
.phasing

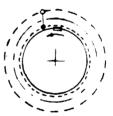




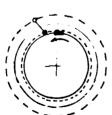
Increase amplitude by "pumping" cable with proper phasing



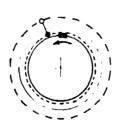
Pass top dead center position and interchange RPV positions



"Pump" cable to decrease oscillations



Coast and continue "pumping"



Stabilize



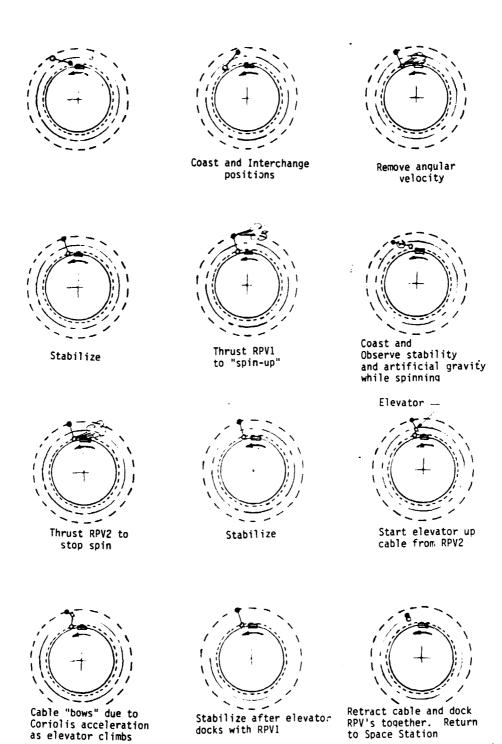
Thrust RPV2 to re-interchange positions

GDC-ASP-83-002

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Code: GDCD 2510

PAYLOAD ELEMENT SYNTHESIS



266.592-478

Section _ Discipline	Fluid & Thermal Physics, Physics and Chemistry
GDCD ID NO.	PAYLOAD ELEMENT NAME
	(NOTE: Experiment facilities for fluid & thermal physics, physics and chemistry disciplines are contained in the general purpose research and development facilities described in Payload Elements GDCD 0400 and 0401.)
2601	Lightweight €ryo Heat Pipes

ORIGINAL DELICATION OF POOR QUALITY

IAME CODE	TYPE
Light Weight Cryo Heat Pipes	
CONTACT W. Hardy/J. Peterson MZ 21-9530 Namo General Dynamics Convair Division Addross P. D. Box 85357	Applications (non-commercial)
	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	X Tachnology
STATUS	Dava to paron t
☐ Operational ☐ Planned ☐ Approved ☐ ○ Opportunity	Operations Tupe Number 16
ght, yr 1992 1ghts 1 of Flight, days 2	(See Table A) Importance of the Space Station to
OBJECTIVE	
Develop the technology necessary to manufacture and process heat pipes using cryogenic working fluids (e.g., hydrogen, nitrogen, oxygen, etc.) in a zero-g environment.	1 - low value but could use 10 - vital
	Scale 1 - 10 10
DESCRIPTION	
The purpose of the mission is to investigate fabrication methods for manufacturing various types of large lightweight cryogenic heat pipes. Toward this end, several types of working fluids, heat-pipe configurations, fabrication techniques and cleaning and processing procedures should be investigated. Types of heat-pipe configurations might vary from a simple cylindrical configuration to more complex designs such as a flat plate sandwich panel or a variable conductance heat pipe. Fabrication techniques such as diffusion bonding or welding could be investigated together with cleaning, fluid charging, and sealing procedures. Several heat pipes will be fabricated and tested in space and their performance recorded. Earth testing will be impossible since the designs will be ultralight weight and not capable of containing the high internal pressures of the cryogenic working fluids at ambient temperature.	s for manufacturing various d, several types of working aning and processing procedure: vary from a simple cylindrica wich panel or a variable connding or welding could be inprocedures. Several heat pipes corded. Earth testing will be capable of containing the high emperature.

CODE 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Apogee, km LEO Perigee, km LEO Tolerance + Inclination, deg Any Tolerance + Nodal Angle, deg Ephemeris Accuracy, m Exame do Reguired m/s
CIF CIF CIF CIF CIF CIF CIF CIF CIF CIF
Opes Sta Per
UNICATIONS grequirements; Realtime 10f ption/Decryption Requir k Req.: Command Rate (K) ard Data Processing Rec
Data Types: Analog Digital Hra/Day Film (Amount) Live TV (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

water or the state of the state to

~	ז	ORI OF	GINAL POOR	PAG:	I 19				
CODE 6.0 C D 2 6 0 1		Remote Nupressurized H.m 0.5 H.m 0.5 Hydrogen, Nitrogen,		7 2	Roason Set Up/Charge/Remove Hravello 176	Z Consumables, kg 10 Hz, 100N	CONFIGURATION CHANGESIInterval, day Man Hours Man/Hrs Rog.	SPECIAL CONSIDERATIONS/See Instructions Anti-Earth, anti-solar pointing. Individual heat pipes of 25 mm to 250 mm in diameter. Three pipe sizes each used for 3 working fluids at 4 charge levels for total of 36 tests, 1 per week. Vacuum pump services required. Peak power 5000W, 5 min, 4 times per pipe during mission.	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 2601 ELEMENT NAME LIGHT WEIGHT CRYO HEAT PIPES

ACCOMODATION: X ATTACHED FREE FLYER OTV OPS

for earth return

Volume II, Book 1
Appendix I

DATE(S) 1992 INT. HRS EVA HRS 8 EVA CREW	1. STATION ACTIVATION (E.G., SET-UP/ASSI	EMBLY/ATTACHMENT AND CHECKOUT)
2. SERVICE (E.G., REPLENISH/RESUPPLY) INTERVAL 7 _ DAYS	DATE(S) 1992 INT. HRS 2	EVA HRS <u>8</u> EVA CREW <u>2</u>
2. SERVICE (E.G., REPLENISH/RESUPPLY) INTERVAL 7 _ DAYS	O NOT ARRIS	
INTERVAL 7 DAYS TOTAL SERVICES 36	☐ NOT AFFEIGABLE	
TMS/OTV REQUIRED	. SERVICE (E.G., REPLENISH/RESUPPLY)	
EVA HRS PER SERVICE 4 EVA CREW SIZE 1 S. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.) 1.6 HRS PER DAY (INTERNAL) HRS PER DAY (EVA) NOT APPLICABLE B. RECONFIGURATION INTERVAL DAYS TOTAL RECONFIGS. WIND APPLICABLE EVA HRS PER RECONFIG. EVA CREW SIZE S. DEACTIVATION/REMOVAL DATE(S) 1992 INT. HRS. EVA HRS 8 EVA CREW 2 NOT APPLICABLE NOT APPLICABLE NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE) 1. Unpackage and set-up heat pipe experiment and radiator. Checkout instrumentation, heaters. 2. Initial change of working fluids. 36 tests total @ 1/wk, 3 different wo fluids. Man would assist in returning working fluid to accumulator. 3. Initialize test and monitor internal pressure, temperatures heat inputs.	INTERVAL 7 DAYS TOTAL SE	RVICES36
EVA CREW SIZE 1 3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.) 1.6 HRS PER DAY (INTERNAL) HRS PER DAY (EVA) NOT APPLICABLE RECONFIGURATION INTERVAL DAYS TOTAL RECONFIGS. TMS/OTV REQUIRED STATION HRS PER RECONFIG. EVA CREW SIZE DAYS TOTAL RECONFIG. EVA CREW SIZE DAYS TOTAL RECONFIG. EVA CREW SIZE DAYS TOTAL RECONFIG. EVA CREW SIZE NOT APPLICABLE NOT APPLICABLE NOT APPLICABLE NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE) 1. Unpackage and set-up heat pipe experiment and radiator. Checkout instrumentation, heaters. 2. Initial change of working fluids. 36 tests total @ 1/wk, 3 different wo fluids. Man would assist in returning working fluid to accumulator. 3. Initialize test and monitor internal pressure, temperatures heat inputs.	TMS/OTV REQUIRED	STATION HRS PER SERVICE4
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DATE(S) 1992 INT. HRS EVA HRS 8 EVA CREW _2		EVA CREW SIZE
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Initialize test and monitor internal pressure, temperatures heat inputs.	Initial change of working fluids. Man would assist	filuids. 36 tests total @ 1/wk, 3 different work in returning working fluid to accumulator
	Initialize test and monit	or internal pressure, temperatures heat inputs.

TOTAL EVA HRS 176

Page 1 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2601

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Lightweight Cryo Heat Pipes

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation meeting, NASA Hg., 14-15 Sept 1982

- AIAA-80-0212, Performance Testing of a Hydrogen Heat Pipe, 18th AIAA Aerospace Sciences meeting, Pasadena, CA, J. Acario and R. Kosson, Grumman Aerospace Corp, Bethpage, NY, 14-16 Jan 1980
- 3. AIAA-80-0211, State of the Art on Cryogenic Heat Pipes, 18th AIAA Aerospace Sciences meeting, Pasadena, CA, R.C. Plager and A. Basiuulius, 14-16 Jan 1980
- 4. The International Heat Pipe Experiment, 2nd International Heat Pipe Conference 1976, R. McIntosh, S. Ollendorph, A. Sherman, NASA GSFC and W. Harwell Grumman Aerospace

Narrative:

The Heat Pipes of various diameters (1-10-in. diameters) would be made of extruded aluminum meticuously cleaned and charged with clean dry N_2 on the ground. On-orbit the pipes would be charged with the working fluid (nitrogen, hydrogen, oxygen) at various pressures.

Power is for instrumentation e.g., pressing transducers, temperature thermocouples) and for calibrated electrical heat input.

Approximately 100 measurement points x 2 samples per second x 8 bits provide the basis for the data rate at 2 kbps. The overall concept of the experiment is from Ref 1. Derived characteristics are from Ref 2, 3, and 4.

Working fluid is based on peripheral wall grooves 0.78-in. diameter per Ref 2. Three working fluids, 7 pipe sizes between 1-in. and 10-in. diameter and four charal levels were assumed. Approximately 6 months of payload operations are envisioned.

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Page 2 of 3 Volume II, Book 1 Appendix I

Code: GDCD 2601

PAYLOAD ELEMENT SYNTHESIS

A vacuum pump would be required to capture working fluid in the accumulator prior to change of working fluid.

Pinch-off of the tubes uses a heated tool applied locally to a special stainless steel nozzle.

The instrumentation layout for the heat pipe is described from Ref 2. "A total of 10 thermocouples, each positioned at the 3 o'clock orientation, were used on the heat pipe proper; four each on both the evaporator and condenser sections, and two on the transport section. Two thermocouples were located on the heat pipe charge tube so that the heat transfer from the reservoir could be measured. Two more thermocouples monitored the reservoir temperature to ensure that it was always slightly warmer than the evaporator. A trace heater was attached to the reservoir so that any liquid trapped in it could be vaporized and returned to the heat pipe."

Code: GDCD 2601

PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Space Manufacturing Langley Contact: Charles J. Camarda

and Processing Technology Development

Experiment Title: Fabrication of Lightweight Cryogenic Heat Pipes

Mission Objectives: Develop the technology necessary to manufacture and process heat pipes using cryogenic working fluids (e.g., hydrogen, nitrogen, oxygen etc.) in a zero-g environment.

Mission Description: The purpose of the mission is to investigate fabrication methods for manufacturing various types of large lightweight cryogenic heat pipes. Toward this end, several types of working fluids, heat-pipe configurations, fabrication techniques and cleaning and processing procedures should be investigated. Types of heat-pipe configurations might vary from a simple cylindrical configuration to more complex designs such as a flat plate sandwich panel or a variable conductance heat pipe. Fabrication techniques such as diffusion bonding or welding could be investigated together with cleaning, fluid charging, and sealing procedures. Several heat pipes will be fabricated and tested in space and their performance recorded. Earth testing will be impossible since the designs will be ultralightweight and not capable of containing the high internal pressures of the cryogenic working fluids at ambient temperature.

Benefit: Heat pipes may play a very large role in space as radiators for space stations or satellites or possibly in the design of thermally inert distortion free structures such as large space antennas or optical systems such as lasers or telescopes. Most of the above applications will require heat pipes using cryogenic working fluids whose structural design will be dominated by the very high internal pressures of the cryogenic fluids at room temperature. Manufacture of these heat pipes in space would result in large savings in mass.

Justification: The fabrication of large ultralightweight cryogenic heat pipes (approximately 50 ft.) will require extended use of a large, low temperature environment afforded by the space station. Also, the need for human interaction is necessary in the fabrication as well as the testing aspects of the experiment since ground testing is not feasible.

Mission Requirements and Capability: Low temperature cryogenic area necessary for fabricating heat pipes 50 feet or longer. Power necessary for welding or diffusion bonding and for testing and data collection should be at normal levels.

Space Station vs. Free Flyer: The proposed experiment needs continued human interaction during the fabrication and test processes. It is not conceivable that fabrication be done on a free flyer because of the complexity of procedures involved in the fabrication, cleaning, and processing of the heat pipes.

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OTHER MISSIONS
OPERATIONAL

Section	4.1 Maintenance
GDCD ID NO.	PAYLOAD ELEMENT NAME
	No payload elements identified in this discipline.

Section 4.2

Discipline Other

GDCD ID NO.	PAYLOAD ELEMENT NAME
4000	Manned Geosynchronous Sortie Capsule
4001	Manned Geosynchronous Support Module

and the second second second second

		Page 1 of 3
E Center in Mine EO Sortie Capsule	G D C D 4 O O O	IYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530		Applications
General Dynamics Convair Division Addross P.O. Rox 85357		(Non-Commercial)
		- Commercial
Telephone (619) 277-8900, Ext. 3778/2130		Technology
nal		X Operations
HpprovedOpportunity		Number
11ght, yr 1999		(see Table A)
Duration of Fight, dans		Importance of the
		this Element
Demc trate manned capability for geosynchronous operations. as a precursor to long-term manned geosynchronous operations.	perations operations.	1 - low value but
		10 - vital
		Scale 1 - 10 4
DESCRIPTION The manned geosynchronous sortie capsule is delivered by the Shuttle to the Space Station where systems are checked out and the capsule is managed. The capsule could be mated to the capsule is managed to the capsule could be mated to the capsule is managed to the capsule could be mated to the capsule of the capsule could be mated to the capsule capsule could be mated to the capsule c	sortie capsule is delivered by out and the capsule is made.	red by the Shuttle to the red. The capsule could be
mated to the upper stage at LEO prior to departure, or the capsule/up of stage could be solivered simultaneously. The upper stage delivers the capsule to GEO where it remains attached for 1 - 2 days while manned operations are conducted. The upper stage injects the capsule into return transfer orbit. The capsule uses aerodynamic braking to assist in return-	the capsule to conducted. The capsule to conducted. The es aerodynamic	of the stage could be could be could be composed the couper stage injects the praking to assist in return-
ing to LEU. Initial launth is 1999, one per year therealter.	nereal ter.	

OR	IGINAL	PAGE	:3
	POOR		

m		or Fook Q	UALITY			
CODE 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	ORBIT CHARACTERISTICS Apogee, km 35,786 Perigee, km 35,786 Tolerance + Inclination, deg 0 Tolerance + Nodel Angle, deg Ephemeris Accuracy, m Escane du Remuired.m/s	OINTING ORIENTA Iow direction ruth Sites (If ointing accuraction ting Stabili	PUJER PUJER Operating Standby Peak Voltage, V	UNICATIONS grequirements;	1477 1084	Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

ORIGINAL DAME TO OF POOR CUASIFY

	G D C D 4 0 0 0	C
Passive operational min non-operational min operational min non-operational min	x x x	OF POU
EQUIPMENT PHYSICAL CHARACTERISTICS Location: Internal External Remote Equipment ID/Function Pressurized Vunpressurized L,m 4.4 U,m 3.3 H,m L,m L,m U,m W,m 4535 Consumables Types Consumables Types Acceleration sensitivity, g min	3.3 Stowed Deployed	
1	P/L Handling and Checkout	
SKILL LEUEL LEUEL Hrs/Da		
	Hra/FUA	
Consumables,		
les, kg	Returnables, kg	
SPECIAL CONSIDERATIONS/See Instructions		_
Power will be self-supplied during checkout. Capsule consists of command module (Apollo shape) with reusable aerobrake and service module (propulsion and fuel cells). Total of 6 sortie missions, 1/year starting in 1999. Service required between missions; LEO or Earth location TBD.	command module (Apollo shape) ells). Total of 6 sortie mis- ; LEO or Earth location TBD.	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GC	CD CODE	4000		ELEME	NT NAME	MANNE	GEO_	SORTIE	ÇAPS	SULE		-
AC	COMODAT	rion:	☐ ATTA	CHED	X FRE	E FLYER	⊠ 01	TV OPS				
1.	STATION	ACTIVAT	10N (E.G.,	SET-UP/	ASSEMBLY	//ATTACHM	ENT AN	D CHECK	OUT)			
	DATE(S)_	1999	INT.	HRS		EVA HRS		EV/	A CREW	·		-
	,						<u>.</u>					_
	C) NOT	T APPLICA	ABLE									
2.	SERVICE	(E.G., RE	PLENISH/F	RESUPPL	Y)							
	INTERVA	L 360	DAYS	TOTAL	LSERVICE	s	_					
	☐ TMS	VOTV RE	QUIRED_			ST	ATION H	IRS PER S	ERVIC	E		-
	☐ NO1	CAPPLICA	ABLE _	_		EV	A HRS P	ER SERVI	CE			_
						EV	A CREW	SIZE				-
3.	STATION	OPERAT	IONAL SUI	PPORT (A	VG. TIME	FOR MONI	TOR, INS	PECT, ET	C.)			
	12	_ HRS PE	R DAY (IN	TERNAL	.)							
		_HRS PE	R DAY (E)	/A)								
	□ NO1	C APPLICA	ABLE									
4.	RECONFI	GURATIO	ON -									
	INTERVA	L	DAYS	TOTA	AL RECON	FIGS						
	☐ TMS	VOTV RE	QUIRED			STA	ATION H	RS PER RI	ECONF	IG		_
	⊠ NOT	APPLICA	ABLE			EV	A HRS PE	ER RECON	IFIG.			-
						EV	A CREW	SIZE			_	
5.	DEACTIV	ATION/R	EMOVAL									•
				HRS		EVA HRS_		EVA	CREW			_
						_						-
	⊠ N01	r applica	ABLE			_						
6.	NOTES (B	RIEFLY	DESCRIBE	TASKS II	N 1 THROL	JGH 5 ABO\	/E)					

- Initial launch date, one flight per year for 6 years.
 Service required between missions. Service location (LEO vs Earth) is TBD
 2 man crew for P/L handling and P/L checkout (sortie capsule is manned when launched from LEO

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Code: GDCD 4000

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Manned Geosynchronous Sortie Capsule

Reference Documents:

- 1. Discussions with JSC, 2 Feb 1983
- 2. Nominal Mission Model, Rev. 6, MSFC PSO1, 9/30/82

Narrative:

The data for this payload element is based on Ref 1 using a stretched Centaur or equivalent upper stage.

The launch data is from Ref 2.

Crew data and mission duration are derived. assuming payload handling at LEO is required. Payload handling on return from GEO is assumed to be routine station operations. The checkout concept assumes an automatic system controlled and monitored by station crew. Top off of Sortie Capsule fuel cells or upper stage cryogenics may be required.

	Page 1 of 3
PAYLOAD ELEMENT NAME Manned GEO Support Module	TYPE
CONTACT W. Hardy/J. Peterson MZ 21-9530 Name General Dynamics Convair Division	Applications (non-commercial)
San Diego, CA 92138	Commercial
Telephone (619) 277-8900, Ext. 3778/2130	Tachnology Develorment
na (X Operations
☐ Approved ☐ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	
First flight, yr 2002 No. of flights 1 Duration of Flight, days 1	
OBJECTIVE	this Elomont
Provide short-term support for man to perform geosynchronous altitude operations (e.g., Earth observations) as a precursor to an operational GEO platform.	1 = low value but could use 10 = vital
	Scale 1 - 10 4
DESCRIPTION The operations concept uses the Shuttle to deliver the support module/upper stage to low Earth orbit or the module could be mated to upper stage at LEO prior to departure. The upper stage delivers the module to GEO (unmanned) for rendezvous with a manned sortie capsule (Ref. GDCD 4000). The support module provides crew accommodations for approx. 2 weeks. The sortie capsule is used to return the crew to the Space Station or Shuttle at LEO. The support module remains on orbit awaiting the next manned sortie mission.	the support module/upper tage at LEO prior to depar- rendezvous with a manned w accommodations for approx. ace Station or Shuttle at LEO. tie mission.

OF PUCK CONSTR

(7))	:	OF POUR (SERVE	, t	
G D C D 4 O 0 1 Page 2 of	1 4 1 1	ENTAT (If k uracy bilit	POWER Operating Power, U Duration, hrs/day Standby Continuous Peak Voltage, V	MUNICATIONS ng requirements: Realtime Of yption/Decryption Requir nk Req.: Command Rate (Ki oard Data Processing Req	Data Types: Analog Digital Hrs/Day Film (Amount) Live TU (Hrs/Day) On-Board Storage (MBIT) Data Dump Frequency (Per Orbit) Recording Rate (KBPS)

	<u></u>		·		·		11			11 1		11		
	Page 3 of		7	Deployed		and Checkout				-		kg	jon equipment	
CODE 6 D C D 4 O 0 1	XSE	ABX TBX	ssurized _{4.5}	• • •	MIN HOW	P/L Handling	5	2 4	Hrs /5110	ıl	•	Roturnables,	Pectric ConsiderAllONS/Sob Instructions Power will be self-supplied during checkout. Support module provides refrigeration equipment for upper stage boil-off.	
	lonal min		Zed⊠Unpre	kg Types	n sensitivity, g	Task Assignment	7	Day 8	uo uo	Cons	day Man Hours	bles, kg	tructions neckout. Support modu	
	Passive C operat	Non-operational	tion Lin	Concrebios	1	7	B)	Hrs/Dau	No N	TENANCE	CONFIGURATION CHANGES Interval, day	Delloara	ENHILONS/See Instructions f-supplied during checkout. Suppoil-off.	
	THERMAL TAMPORTIVE Temperature, deg	EQUIPMENT PHYS			CREU REQUIREMENTS	Crew Size	Skills (See Table		EUA [] YES	SERVICING/MAINTEN/ SERVICE: Interval,	CONFIGURATION	SPECTOT CONCINC	Power will be self-supplifor upper stage boil-off.	

GDC-ASP-83-002 PAYLOAD ELEMENT OPERATIONS DESCRIPTION

Volume II, Book 1 Appendix I

GC	CO CODE 4001 ELEMENT NAME MANNED GEO SUPPORT MODULE
ΑC	COMODATION: ATTACHED FREE FLYER OTV OPS
1.	STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)
	DATE(S) INT. HRS EVA HRS EVA CREW
	□ NOT APPLICABLE .
2.	SERVICE (E.G., REPLENISH/RESUPPLY)
	INTERVAL DAYS TOTAL SERVICES
	☐ TMS/OTV REQUIRED STATION HRS PER SERVICE
	■ NOT APPLICABLE EVA HRS PER SERVICE
	EVA CREW SIZE
3.	STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)
	12 HRS PER DAY (INTERNAL)
	HRS PER DAY (EVA)
	□ NOT APPLICABLE
4.	RECONFIGURATION
	INTERVAL DAYS TOTAL RECONFIGS
	☐ TMS_OTV REQUIRED STATION HRS PER RECONFIG.
	☑ NOT APPLICABLE EVA HRS PER RECONFIG.
	EVA CREW SIZE
5.	DEACTIVATION/REMOVAL
	DATE(S) INT. HRS EVA HRS EVA CREW
	☑ NOT APPLICABLE
6.	NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)
l. 3.	1 flight required 2 man crew for P/L handling, and checkout. Support module launched unmanned. Payload remains at GEO orbit.

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Code: GDCD 4001

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Manned Geosynchronous Support Module

Reference Documents:

- 1. Discussions with JSC, 2 Feb 1983.
- 2. Nominal Mission Model, Rev. 6, MSFC PSO1, 9/30/82

Narrative:

The data for this payload element is based on Ref 1 using a stretched Centaur, or equivalent, upper stage.

The launch data is from Ref 2.

Crew data and mission duration are derived assuming payload handling at LEO is required. The checkout concept assumes an automated system controlled and monitored by the Space Station crew (or by the Shuttle).

APPENDIX II SPACE STATION USER BROCHURE AND FACT SHEET

GDC-ASP-83-002

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SPACE STATION USER BROCHURE

SPACE STATION USER FACT SHEET

GDC-ASP-83-002

INTRODUCTION

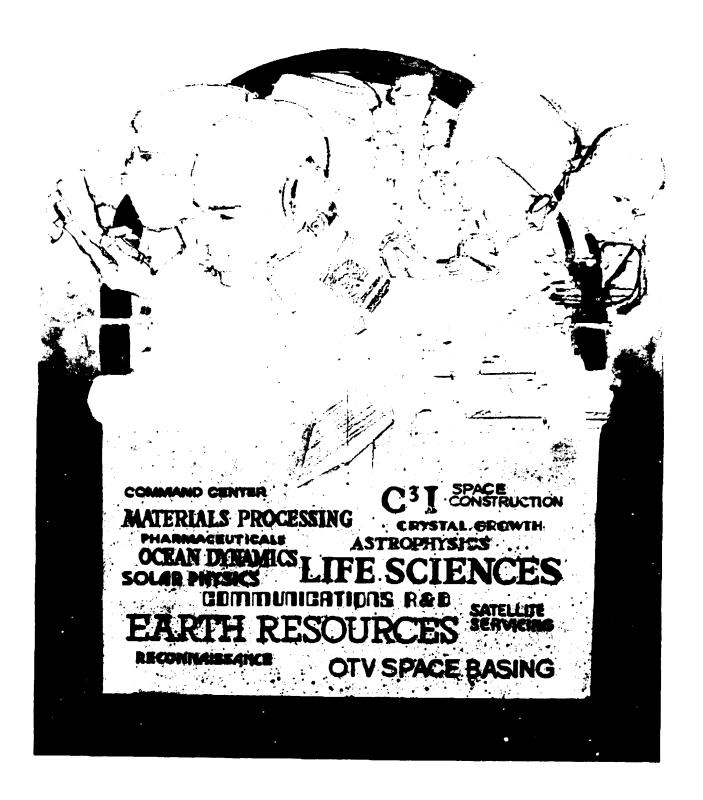
The Space Station User Brochure and Fact Sheet have been developed by General Dynamics Convair Division in support of the National Aeronautics and Space Administration's Study on the Space Station Needs, Attributes, and Architectural Options (Contract NASW 3682). The brochure has been provided to a select group of organizations that qualify for consideration as potential Space Station users.

There were two purposes for this brochure. First, to present potential user organizations with vital information regarding the scientific and industrial opportunities that a Space Station might present. Second, to offer potential users an opportunity to become directly involved in NASA's Space Station program. The brochure details the potential technological and economic benefits of a manned Space Station, while also offering a concise summary of America's current and planned space activities. The accompanying User Fact Sheet allows potential users to influence Space Station program planning by identifying economic planning factors as well as areas of insterest in Space Station provisions.

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SPACE STATION USER BROCHURE



GENERAL DYNAMICS

Convair Division

INTRODUCTION

The Space Station User Brochure has been developed by General Dynamics Convair Division in support of the National Aeronautics and Space Administration's current Study on Space Station Needs, Attributes, and Architectural Options. The brochure has been provided to a select group of organizations that qualify for consideration as potential Space Station users.

There are two purposes for this brochure. First, we want to present potential user organizations with vital information regarding the scientific and industrial opportunities that a Space Station might present. Second, we want to offer potential users an opportunity to become directly involved in NASA's Space Station program. The brochure details the potential technological and economic benefits of a manned Space Station, while also offering a concise summary of America's current and planned space activities. The accompanying User Fact Sheet allows potential users to influence Space Station program planning by identifying areas of interest in Space Station provisions.

General Dynamics encourages all potential users to read the Space Station User Brochure and to return the completed Fact Sheets to General Dynamics Convair Division as early as is practical. This represents an excellent opportunity for all interested organizations to participate in and shape the development of an important new program.

Prepared by
SPACE STATION PROJECT
GENERAL DYNAMICS CONVAIR DIVISION
P.O. Box 80847
San Diego, California 92138

MR. OTTO STEINBRONN Mail Zone 21-9530 Phone (714) 277-8900 x-6082

SPACE STATION OPPORTUNITIES

The development of a manned Space Station will provide many opportunities for new and improved uses of space. In scientific research and applications, the establishment of a permanent human presence in space will improve our ability to carry out, interpret, and modify a broad variety of experiments, particularly in the life sciences. The Space Station will also provide new opportunities for commercial use of space, notably in such areas as materials processing and space transportation. This section describes some of the significant opportunities that may develop in these areas over the next several years.

SCIENCE AND APPLICATIONS

By providing a base for continuous research and applications activities of unlimited duration, the Space Station will open up opportunities for scientific investigation previously unavailable. The Space Shuttle, particularly when used with the European-built Spacelab, will support hundreds of independent scientific activities over the next decade, but is limited in effectiveness by its size and its maximum stay-time in orbit.

Using a modular design, a Space Station could be expanded indefinitely to support simultaneously a number of large scientific instruments, which could be flown in the Shuttle only one at a time. Whereas the Shuttle can remain in orbit for a maximum of only seven days (slightly longer with modifications to the orbiter power supply) a Space Station could support space science and applications experiments of many months or even years duration.

With less stringent limitations on experiment size and duration, the Space Station will provide unique opportunities and cost benefits to researchers in such fields as earth and space observation and space processing R&D. Large telescopes and other such instruments could be attached directly to the Space Station, or could be supported on co-orbiting, free-flying platforms within easy access to the Space Station crew. The ability to modify and repair experimental facilities on short notice will be another key advantage of using a Space Station for space science and applications.

In the area of applications, the Space Station will provide opportunities to improve earth obser-

vation instrumentation and to enhance remote sensing by adding human monitoring capabilities. Applications of remote sensing include such environmental observations as air quality monitoring, detection of ocean currents, and weather prediction. (Earth resource monitoring, the other primary remote sensing activity, is discussed in "Commercial Utilization," below.) The presence of humans in space will help to ensure that local changes in the earth's environment can be picked up by remote sensing instruments, and will also provide an in-space capability for handling data and correcting technical problems.

Important benefits of the Space Station for science and applications will be realized in the field of life sciences. The Space Station will permit research on the long-term effects of the space environment on humans and other living systems, far surpassing the capabilities of the Shuttle and the now-extinct Skylab. By combining the ability to repair or modify life sciences experiments on a moment's notice with this capability for long-duration observation and experimentation, the Space Station will provide great new opportunities for:

- Improving the health and performance of humans living and working in space.
- Increasing our understanding of life processes both in space and on Earth.
- Understanding the origin, evolution, nature, and distribution of life in the Universe.

In the more distant future, the Space Station could play a role in such scientific and applications endeavors as the collection and processing of nonterrestrial materials (e.g., lunar ore) on an experimental scale, and the staging of unmanned and manned interplanetary (or even intergalactic) missions. By the time the Space Station exhausts its utility to the scientific community, missions such as these might seem primitive.

COMMERCIAL UTILIZATION

As a vital step in the direction of space industrialization, the Space Station will create significant and varied opportunities for commercial use of space. Near-term business opportunities in such areas as commercial materials processing in space and flight support operations could generate several billions of dollars in revenue annually by the middle of the next decade, while such long-term activities as extra-terrestrial mining and space construction provide the potential for virtually limitless industrial growth in space.

Several large companies have already taken steps to capitalize on the commercial potential of materials processing in space (MPS). McDonnell Douglas Astronautics Co. and Ortho Pharmaceutical Co. (a subsidiary of Johnson and Johnson) have committed tens of millions of dollars to a Joint Endeavor with NASA aimed at commercialscale electrophoretic separation of high-value pharmaceuticals in space. The properties of zero gravity are expected to create opportunities for the production of other valuable materials in space, such as gallium-arsenide, a crystal used in semiconductors, which could have a profound impact on the electronics industry. NASA's Materials Processing in Space Office has been working with private industry for over five years to identify commercially viable MPS opportunities, and arrangements such as NASA's Joint-Endeavor program are being used to encourage the use of the Space Shuttle for MPS.

By providing more power and greater production time than the Space Shuttle, the Space Station will permit the production of much greater quantities of materials than would be possible on the Shuttle, opening up new opportunities for commercial MPS. The element of manned presence will aid in the improvement and creation of new processes, further enhancing the prospects for commercial space processing.

As a staging base for high-energy upper stages, the Space Station may open up commercial opportunities in space transportation that could impact the evolution of the entire space communications industry. Initial studies have indicated that a reusable orbital transfer vehicle (OTV) based at a Space Station could deliver payloads to geosynchronous orbit more cheaply than any other available means. Based on traffic models projecting launches of some five hundred communications satellites over the next twenty years, the market for OTV launch services could exceed \$20 billion within the communications industry alone.

The reduction of launch costs could in turn stimulate the development of larger and more capable communications satellites, creating opportunities both on Earth for advanced communications equipment (e.g., "wristwatch" telephones), and in space for satellite servicing. OTV operations could also represent an attractive business opportunity in the launch of non-communications payloads, such as scientific instruments, to high or interplanetary orbits.

Another area of potential commercial involvement in Space Station operations is in remote sensing. Earth resource observations can be used to detect geological minerals, petroleum, or to monitor development of crops, water resources, and timber. As in the area of environmental observations (discussed in "Science and Applications" above), a manned Space Station will provide opportunities to increase the operational effectiveness and reliability of these remote sensing systems.

The Space Station could create other business opportunities in the intermediate- and long-term in such areas as use of nonterrestrial materials and space construction. These technologies could be used in such activities as the development of large power systems for provision of energy in space (and to Earth, if it becomes economically and environmentally feasible) and perhaps even the establishment of permanent human settlements in space. As a prerequisite to all of these developments, the Space Station represents a key early investment opportunity in the industrialization of space.

SPACE OPERATIONS

Provision of operational support to Space Station users represents an opportunity for organizations which are not traditionally space-oriented to become involved in Space Station development and operation. In addition to OTV flight support operations (see "Commercial Utilization), Space Station users will require data handling, utilities such as power, environmental management (i.e., food, water, waste disposal, etc), and other support. Development and provision of the technological and economic means of providing this support could become a valuable investment opportunity for Space Station "providers" of services.

SPACE TRANSPORTATION SYSTEM ATTRIBUTES

The Space Shuttle is the key to routine U.S. access to space. It is the major technological factor that permits economic emplacement and support of a permanent manned facility in low earth orbit.

As illustrated in Figure 1, the Shuttle will fulfill many functions in the overall Space Transportation System (STS) scenario, and its role will change with time. Initially, delivery of low earth orbit (LEO) spacecraft, geosynchronous orbit (GEO) spacecraft with upper stages, and space sortie payloads will account for almost all of its missions.

Later, it will add LEO spacecraft servicing and retrieval, and Space Station delivery and assembly capabilities. Finally, as the Space Station grows and evolves into the predominant U.S. space presence, the Shuttle, which was originally conceived as a transportation system to provide routine and economical access to a manned Space Station, will transition from a mission performance vehicle to its primary role as a transportation vehicle, allowing the full potential of the Shuttle to be realized.

The Space Station will be a key element in making Shuttle operations more economical and efficient as it serves as a staging base for transferring payloads to other orbits. This will relieve the Shuttle of its on-orbit operational role so that it can focus on transportation from earth to LEO and return.

As the scale of Space Station activities expands, user economic benefits will accrue because of lower net transportation costs and economy of scale in providing payload supporting services.

The following sections describe the present and planned elements of the STS, and discuss the principles that will lead to more economic operations in space as these elements evolve in capabilities.

STS SYNOPSIS

Major elements of the STS through the year 2000 will be:

- Space Shuttle
- Spacelab
- Free Fivers
- Space Platform
- Space Station
- Orbit Transfer Vehicles
- Support Facilities

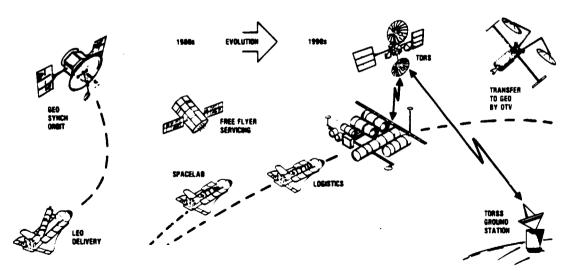


Figure 1. Space Shuttle supports all elements of the total STS scenario with an evolutionary role that parallels the Space Station program.

Space Shuttle — Payload elements can be mounted directly to standardized attachment fittings along the sides and bottom of the Orbiter's cargo bay.

The payload clearance envelope in the cargo bay measures 18.3 m (60 ft) in length and 4.6 m (15 ft) in diameter.

The cargo bay is vented to the exterior ambient pressure during flight. The Orbiter supplies basic services such as power, cooling and data management. Payloads can be controlled from the Orbiter's aft flight deck or from the ground.

A small amount of payload equipment (e.g., 2 to 4 m³) can be accommodated within the Orbiter cabin, where limited power, cooling and data management services are provided.

The choice of location will depend on factors such as size, the need for manned access, and whether the equipment requires direct exposure to space.

The Orbiter carries a crew of at least four for payload deployment and retrieval missions and as many as seven for Spacelab flights. In addition to the Commander and Pilot, one or two Mission Specialists will be available to operate the remote manipulator system, docking and berthing devices, and other Orbiter subsystems and auxiliary equipment. The mission specialists are trained astronauts and are EVA-capable (extra-vehicular activity).

Three or four Payload Specialists may be carried who are trained in the operation of specific experiments. The relatively benign Shuttle environment and shirtsleeve laboratory operations require a minimum of acclimation by scientists and engineers.

The Orbiter can launch as much as 29,484 kg (65,000 lb) of payload equipment into a low inclination, low altitude earth orbit. Higher altitudes and/or inclinations somewhat reduce this launch capability.

The weight of cargo returned to earth is limited to 14,514 kg (32,000 lb), due to Orbiter landing weight constraints.

In the pre-Space Station era, Shuttle missions will be devoted primarily to deliveries of autonomous spacecraft to low earth orbit (LEO) and to deliveries to LEO parking orbit of geosynchronous orbit (GEO) spacecraft with orbit-to-orbit transfer stages, and earth-escape missions. A

small percentage of the Shuttle flights will be devoted to Spacelab missions.

To improve launch factors, many satellite delivery missions will include two or three satellites in the cargo manifest (see Figure 2) and some will also include a palletized science or materials-processing payload in the cargo bay to take advantage of remaining time on orbit; i.e., three to four days.

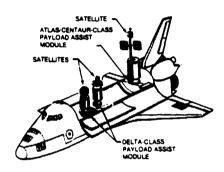


Figure 2. Multiple small satellites can be launched on each Shuttle flight.

In the Space Station era, the predominant role of the Shuttle will be to serve as a logistics vehicle for the station and station-related operations. After initial Space Station buildup, the Shuttle's major functions will be to provide for crew rotation, resupply consumables, deliver equipment and raw materials to the station, and to return manufactured products and wastes to earth.

The currently planned four-Orbiter fleet may have to be expanded to accommodate the increased earth-to-LEO traffic in the Space Station era.

Spacelab — The array of possible Spacelab configurations (combinations of large or small modules and/or number of pallet sections) provides a wide range of payload mass capabilities and pressurized or unpressurized accommodations (see Figure 3).

The large module can accommodate up to approximately 6,000 kg and 20 m³ of payload equipment. Present planning includes about three Spacelab missions per year after 1983. These missions are scheduled for a seven-day duration. Intensive preflight payload integration and crew training efforts, and mission timeline controls are

necessary to make the most out of the short onorbit stay time available. Longer-duration (up to 30 days) missions are feasible, but at the expense of payload weight penalties to account for missiondependent consumables and, possibly, a power extension package.

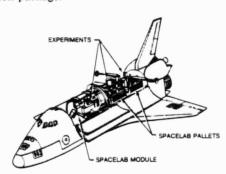


Figure 3. Spacelab provides pressurized laboratory and unpressurized instrument mounting facilities.

Free Flyers — The Shuttle will deliver to LEO autonomous, free-flying spacecraft exemplified by the Space Telescope, Solar Max Satellite, Long Duration Exposure Facility (LDEF), Landsat, Advanced X-Ray Astrophysics Facility, and the Gamma Ray Observatory.

Figure 4 illustrates the Solar Maximum Satellite (SMS) which consists of a Solar Astronomy payload supported by a Multimission Modular Spacecraft (MMS).

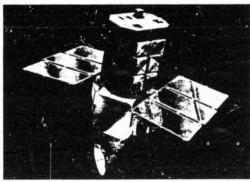


Figure 4. SMS is a typical MMS application that is serviceable on orbit and is retrievable for refurbishment and reuse.

The MMS has been developed by NASA as a standard modular spacecraft, that can be used in both low and high orbits. Within its standard range of capabilities, it can be adapted to many varied payload requirements, eliminating the need for costly and time-consuming design and development activities.

The MMS can accommodate payloads in excess of 4,536 kg (10,000 lb) when launched/retrieved by the Shuttle, can supply 800 watts average power to the payload, and has a basic pointing accuracy of 0.01 degree that can be improved by two to three orders of magnitude using a payload sensor-derived signal.

The MMS is also currently used for the LANDSAT-D series of earth observations satellites, and a power-augmented version of the MMS has been proposed to support a free-flying materials processing payload that would manufacture pharmaceutical products in a microgravity environment.

These spacecraft are also being designed for periodic on-orbit servicing using the Shuttle and for Shuttle retrieval for return to earth for refurbishment (see Figure 5).

In the Space Station era, servicing and refurbishment will be possible at a station servicing facility if orbit compatibility permits, or if an appropriate station-based propulsive stage is employed.

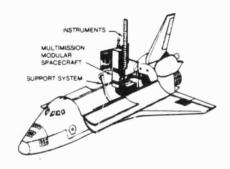


Figure 5. The MMS and its support system permit onorbit servicing and retrieval.

Space Platform — One programmatic option under consideration in the evolution of the STS is the use of an unmanned, free-flying space platform that could accommodate a large complement of science and applications payloads (see Figure 6).

This STS element could provide long mission durations which are desired by many scientific observations. It could also provide high power levels that could permit materials processing in space to enter a commercial scale of operations. Addition of manned modules to the Space Platform could be a step in evolving from a Shuttle-tended to an autonomous mini-Space Station.

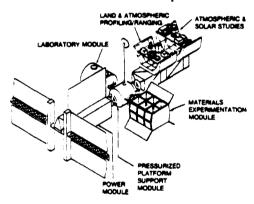


Figure 6. The Space Platform could accommodate payloads with a wide range of viewing, microgravity, and space access requirements.

Space Station — The Space Station will be a manned, permanent orbital facility that will support a wide variety of U.S. and international space missions. It will provide space laboratory and manufacturing facilities, viewing platforms, and operational support functions.

The station will begin as a small science and research-oriented facility with a small crew, and will evolve to a large, multipurpose system with a crew of a dozen or more over the time period of interest. Initially, the crew of scientist/astronauts will be trained to perform Mission and Payload Specialist duties. Later, Principal Investigators and other user representatives will be able to conduct on-orbit Science and Applications research, material processing, and other activities.

Modular design and delivery/assembly by the Shuttle will provide flexibility in accommodating varying user needs. Figure 7 illustrates a representative evolutionary buildup in the station configuration and its mission capabilities.

In the initial buildup phase, users may share laboratory facilities for R&D investigations, while in the advanced stage the facility capabilities can expand to meet user needs; e.g., dedicated manufacturing or processing facilities, space-based OTV propellant resupply and servicing, and launch support for GEO payloads.

Ultimately, two or more Space Stations will be needed by the U.S. to accommodate user requirements for viewing vantage, laboratory and manufacturing facilities in space, electrical power, and other resources.

INITIAL PHASE



- Multidiscipline laboratory
- R&D experiments; e.g., proof of phenomena or proof of concept
- Solar, stellar, earth viewing

OPERATIONAL PHASE



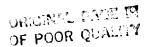
- Additional power, laboratories, habitability
- Operational support for LEO free flyers: service, repair, update
- Process development
- Pilot plant production

ADVANCED PHASE



- Additional power, laboratories, habitability
- Operational support for LEO free flyers: deploy, retrieve, service, repair, update
- Operational support to launch GEO pavioads:
 - Assembly and checkout
 - Space-based OTVs
- Space construction support
- Dedicated full-scale production facilities; i.e., commercialization

Figure 7. Evolutionary growth in station capabilities will be a function of user requirements.



The initial facility will be placed in a lowaltitude orbit, with an orbit inclination in the range of 28.5 to 57 degrees. The lower-inclination orbit would allow the Shuttle to deliver its full 29,484 kg payload, and would provide an efficient waypoint for launching payloads and OTVs to GEO.

The higher-inclination orbits would provide some additional earth viewing opportunities, but at the expense of payload delivery capability. Later, smaller facilities can be emplaced in polar orbit to provide optimum viewing opportunities for solar physics and earth observations.

As the Space Station evolves during the 1990s, the expanded level of commercial and operational activities will generate a diversified flow of equipment, consumables, and products between the station and earth. This diversity will enable the Shuttle operator to plan cargo manifests to obtain nearly 100% load factors, thus minimizing the cost per kilogram transportation costs. Figure 8 indicates this diversity of Shuttle cargo in the Space Station era.

For laboratory and manufacturing facilities, the delivery of equipped modules to orbit and attachment to the station for long periods will significantly reduce the mass flow to and from orbit since only raw materials, manufactured products, and periodic replacement equipment must be transported, rather than the entire facility (as in the case of Spacelab). This long-term emplacement of modules could reduce the mass flow for a typical space-manufactured product to tens of kilograms rather than thousands.

Orbit Transfer Vehicles — The majority of autonomous spacecraft to be launched to LEO by the Shuttle will operate at GEO. In the early years, they will be transferred from the LEO parking orbit into a transfer ellipse by propulsive stages such as the payload assist module (PAM-A and -D), or will be placed in GEO by the inertial upper stage (IUS).

In the later years, this orbit-to-orbit transfer function will be performed by high-energy propulsive stages that can carry larger payloads or can emplace multiple payloads. Initially, the OTV will be carried to LEO along with its payload(s). The Space Station will have no role in these launches. But, as station support capabilities grov, the op-

SINTTLE PUNCTIONS	SMITTILE EIGH (1980s)	SPACE STATUM ENA (1988a)
DELIVERY	SEPTILS A SEE SET	PACE STATUM DR. ROY PAGE PLYEN
LABORATOMES & OPERATIONS	METTLE & SPACELAR	SOURCE SO
LORISTICS		COMMANDED COMPANDED

Figure 8. The diversity of cargo in the Space Station era results in more efficient Shuttle utilization.

portunity will be available to use the station as a launching base for these GEO payloads. This will permit much larger spacecraft to be assembled and checked out in LEO and then transferred to GEO using a station-based, reusable OTV. This capability could also enable the buildup and launch of advanced interplanetary probes and sample return missions.

Support Facilities — Applicable STS support elements include launch complexes and Shuttle and cargo ground processing facilities at Kennedy Space Center (KSC) and Vandenberg Air Force Base (VAFB), and the communications and data-handling network. The Tracking and Data Relay Satellite System (TDRSS) will provide near-continuous, real-time communications links between the Space Station and users on the ground. Other terrestrial and satellite links will tie in to ground control and data analysis stations internationally.

STS PAYLOAD ACCOMMODATIONS

Throughout the 1980s and 1990s, the Space Transportation System will be evolving in capabilities as previously described. This section provides quantified ranges of values of mission support and payload accommodation capabilities of STS elements, beginning with the Shuttle and extending to the Space Station.

Table 1 is a summary of the resources available to payloads. The values shown include estimated ranges for strawman Space Station configurations.

All STS elements will be supported by the Tracking and Data Relay Sate!lite System (TDRSS), which will enable data transfer to the earth at rates of 50 kbps continuously and up to 300 kbps when a single-access channel is available.

Table 1. STS element payload accommodation capabilities will evolve through several growth stages.

			STS Element			
System Attribute Provided to Psyleads	Space Shuttle	Shuttle With Spacelab	Space Platform	initial Space Station	Operational Space Station	Advanced Space Station
Power (kW)	7	2 to 5	10 to 20	10 to 20	20 to 40	≥40
Maximum mission duration	7 to 30 days	7 days	Unlimited	Unlimited	Unlimited	Unlimited
Crew capability	1 or 2	1 to 4	0	1 to 4	4 to 8	≥8
Volume (m ³) (Pressurized) (Unpressurized)	2 to 4 304	17 60	0 500	25 400	50 1,000	> 50 >1,000
Weight (kg)	29,000	6,000 to 9,000	15,000	8,000 to 10,000	10.000 to 20,000	≥20,000
Microgravity (g	10-3	10-3	10 ⁻⁶ to 10 ⁻⁷	10 ⁻⁴ to 10 ⁻⁶	10 ⁻⁴ to 10 ⁻⁶	10 ⁻⁴ to 10 ⁻⁶
Orbital access (km) (deg incl)	100 to 1100 28.5 to 104	185 to 555 28.5 to 104	370 to 555 28.5 to 104	390 to 450 28.5	390 to 450 25.5 to 104	390 to 450 28.5 to 104
Availability	Now .	1983	TBD	1990	1995	TBD

SPACE SHUTTLE & SPACE STATION FINANCIAL DATA

Users of the Space Shuttle and other elements of the Space Transportation System (STS) are required to pay NASA for these services in accordance with reimbursement guidelines established by NASA's Office of Space Transportation Operations. NASA's current STS pricing policy is summarized in the following paragraphs (All prices in 1982 dollars).

REGULAR FLIGHTS

For standard missions to low earth orbit (with cargo space shared among two or more users), each Shuttle user is charged according to the fraction of available Orbiter cargo bay space his payload occupies. Charges are calculated as follows:

Step 1.

Calculate weight load factor =	Payload weight 65,000 lb
Calculate length load factor =	Payload length
	greater of weight: load factor, length load factor
Stop- 2.	

Multiply charge factor by dedicated price.

The dedicated price is the charge a user would pay for use of the entire Orbiter cargo bay, and is presently set at \$70.8 million. A user with a charge factor of 0.10 would be charged 0.10 × \$70.8 million = \$7.08 million. NASA has established a minimum load factor of 0.05 (charge factor = 0.067).

SPECIAL FLIGHTS

Shuttle users with flexible launch dates, very small payloads, or other special characteristics can take advantage of special pricing considerations, which include:

- Standby Basis Users who can prepare payloads on short notice and who have flexible launch dates can fly on a standby basis at a 20% discount. At least 60 days advance notice is provided by NASA.
- Small Self-Contained Payloads (Getaway) Specials) — Users with very small scientific research and development payloads can have their experiments flown in the cargo bay in special NASA-supplied canisters at relatively low cost. Three types of accommodations are available:

Marimum Walght (hg)	Maximum Volumo (m²)	Price
91	0.14	\$18,620
45	0.07	\$ 9.310
27	0.07	\$ 5,586

- Mid-Deck Lockers A limited number of small storage lockers in the Orbiter mid-deck crew compartment are available for payloads that do not require vacuum or large amounts of power. Each locker has 0.057m³ volume and 27.3 kg weight capacity; large lockers (with twice the weight and volume capacity) are also available. Prices for mid-deck lockers have not yet been established.
- NASA-Subsidized Flights Companies with research and development experiments related to materials processing in space (MPS) and aimed at eventual commercialization, can negotiate with NASA for Joint-Endeavor Agreements (JEA). Under terms of a JEA, NASA can provide the industrial JEA participant with flight time on the Space Shuttle (or other elements of the STS) and use of NASA ground facilities in exchange for nonmonetary considerations; e.g., use of samples. There is no established limit to the value of NASA support available to users through JEAs and Joint Endeavor proposals can be submitted to NASA at no cost.

HIGH-ENERGY ORBITS

Users requiring payload launches to high (e.g., geosynchronous) orbits can use upper-stage boosters launched from the Orbiter cargo bay. The approximate costs and capabilities of upper stage services are:

Upper Stage	Poytood Weight Coposity (hg)	Orbit Ashiored	Charge Fester	Shuttle Price (SM)	Upper- Stage Cost (SSA)	Payload Services Charge (SM)	Total Price (SNA)
Delta Payload Assist Module (PAM-D)	1,088	GEO-transfer	0.21	14.9	6.6	1.2	22.7
Atlas-Centaur Payload Assist Module (PAM-A)	2.000	GEO-transfer	0.35	24.8	8.8	3.9	37.5
inertial Upper Stage (IUS)	2,270	GEO	1	70.8	55	10	135.8

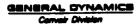
SPACE STATION COSTS

As a possible future STS element, the Space Station could offer potentially significant economic benefits to users with long-duration or high-energy missions. The cost per man-day of crew labor on-board a Space Station has been estimated at about \$135,000°. Other cost bases, such as dollars per kilowatt-hour for electrical service, are TBD.

Launch of high-energy missions for a Space Station could be highly cost-effective. Using a reusable OTV based at a Space Station, an IUS-class (2,270 kg) payload might be delivered to geosynchronous orbit for as little as \$40 million, less than one-third the cost of using the Shuttle-IUS combination.

Exploration of other Space Station uses is expected to identify other economic benefits of a Space Station.

^{*} Boeing, SOC System Analysis Study Extension, Vol. I, Exec. Summery, p. 7.



SPACE STATION USER FACT SHEET

PROPRIETARY DATA

You are requested to clearly identify any information in these fact sheets that you consider to be proprietary. General Dynamics Convair Division agrees that it will use the same reasonable efforts to protect such information as are used to protect its own Proprietary Information. Disclosures of such information shall be restricted to those individuals who are directly participating in the data coordination and interchange efforts.

GENERAL INFORMATION

Organization Name and Address		
Principal Contact		
Phone	Date	
Title of Experiment/Product/Process		
Objective		
	· · · · · · · ·	
		<u> </u>
Summary Description		
		·
	<u> </u>	
Reference Documents		

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CONTENTS

	Page	Ð
Introduction	******************	1
Economic Factors		
NASA Relationship		3
Investment Considerations		3
Space Station Benefits		4
Planning Factors		5
Technical Parameters		7
Mission Characteristics		7
Physical Characteristics		
Resources		8
Environments		2
Crew/Experiment Control	1	2
Space Operations/Logistics		3
Experiment Support		13
Sciety	1	4
Other Accommodation Considerations		

GENERAL DYNAMICS

INTRODUCTION

The fact sheet is divided into three sections. The first, "Economic Factors," is quite general in nature and addresses investment considerations and potential benefits of a Space Station as they apply to industrial organizations. The next two sections, which discuss Planning Factors and Technical Parameters, are somewhat more detailed and are oriented toward capturing data on currently planned space activities or to providing a basis for developing such payload planning data.

Please keep in mind that we are interested in your concepts and ideas (as well as specific data, if available) and that we fully understand that you may not be able to answer many of the detailed planning or technical questions. Answer as many inquiries as you can at this time, and return the Fact Sheet to General Dynamics. The format, organization, and contents are designed to minimize the time required to answer the questions and to recognize the engineering and scheduling uncertainties inherent in long-range planning. We plan to follow up your efforts with future contacts, during which we may be able to offer assistance and work together in further developing Space Station user planning data.

To the majority of inquiries, you can respond by simply checking the applicable answer. However, where more detailed information is available, space has been provided to enter such data. For your convenience, provisions are made for you to use either English or SI units.

The data that you provide to General Dynamics will be used for Space Station program planning purposes only. This is an initial, informal step that will help shape the evolutionary design of the Space Transportation System (STS), particularly the Space Station. Later, as your support requirements and user benefits are defined in greater detail, you will have the opportunity to formalize your participation through the STS Customer Services Office at NASA Headquarters.

Potential user technical requirements data described in these Fact Sheets should be limited to only those resources or services that are required by the user-provided equipment <u>at the interface</u> with elements of the Space Transportation System. Requirements internal to the user equipment should not be described herein. For purposes of these data sheets, the terms "experiment", "product", or "process" have been used interchangeably to indicate the generic function provided by the user equipment

In addition to potential users, this Fact Sheet also addresses inquiries to organizations that may be interested in Space Station-related business opportunities for providing services (such as power or data management support) to Space Station users.

Your organization may be interested in more than one use of space facilities. A separate set of Fact Sheets should be prepared for each different product, process, experiment or operation that has significantly different requirements. (An extra set of Fact Sheets is provided for your convenience.)

MAILING INSTRUCTIONS

When completed, please return this questionnaire to

General Dynamics Convair Division Space Station Project, MZ 21-9530 P.O. Box 80847 San Diego, CA 92138

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ECONOMIC FACTORS

The following questions are designed to provide a general indication of the economic/industrial value of a Space Station for commercial users.

NASA Relationship

NOTES.

l Please check your company's level of direct working experience with NASA.	3. Please indicate how yo level of risk involved in y or planned Space Station	our co	mpar		
□ moderate □ low □ none 2. How would you assess your interest in exploring	☐ great risk ☐ significant risk ☐ average risk ☐ low risk				
possible joint-endeavor arrangements with NASA?	□ not applicable/unkno	OWN			
 □ very interested □ moderately interested □ not interested 	4. Please indicate how significance of the followi in a Space Station?				
unknown			foderat		nknown
Investment Considerations	c. investment level b. investment horizon	מטטכ	ממטכ		
1 Please indicate what you would consider to be the greatest acceptable investment horizon (before realizing dollar returns) in a Space Station-related	c. technical risk d. legal problems e. uncertainty regarding	_	_		_
business venture.	govi commitments				
□ over 20 years □ 15 to 20 years □ 10 to 15 years	5. Please indicate how you talk significance of the Space Station investment	tollov			
☐ 5 to lO years		Great N	Aodera t	e Little U	nknown
☐ Less than 5 years ☐ unknown	a reduced space trans- portation costs		□		
2. Please indicate the greatest level of dollar commitment you could envision your company making toward Space Station utilization.	b. competitive pressure c. govt-sponsored R&D d. govt logistical support (e.g., no-monetary cost		00		
☐ over SIOO million ☐ SIO to IOO million	Shuttle flights) e. govt tox or other				
Sto to 100 million I less than \$1 million unknown	economic incentives				

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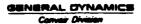
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Space Station Benefits

 How would you characterize the potential of the Space Station to reduce the costs or increase the effi- ciency of the relevant activities you are involved in?
great potential moderate potential tittle potential unknown
2 In your estimation, what would be the approximate net annual dollar value to your company of access to a Space Station?
□ over \$100 million □ \$10 to 100 million □ \$1 to 10 million □ less than \$1 million □ unknown
3. What is your perception of the potential industrial value of a Space Station?
unlimited value high value marginal value little value unknown
4. Please explain any other economic factors that you teel are significant in "Notes."

NOTES:



PLANNING FACTORS

The following questions will provide an initial overview of how your organization's uses of space resources could evolve during development of space-related products/services. For each specific space-related program you are considering or have under way, please check the appropriate column(s) based on your current understanding of the phases of your product development cycle and the STS and its attributes and opportunities. For example, if the Space Shuttle could be used for demonstration of your product/process and for pilot commercialization, check () columns B and C for item.

OPERATIONAL CAPABILITIES

For which activity phase(s) does your organization anticipate...

- 1. Using the Space Shuttle?
- 2. Using the Space Shuttle with Spacelab?
- 3. Needing an unmanned Space Platform?
- 4. Needing a manned Space Station?
- 5. Needing trained scientists/astronauts?
- 6. Launching payloads to high (e.g., geosynchronous) orbits?
- 7. Launching payloads over 2270 kg to high orbits?
- 8. Retrieving and/or repairing orbital satellites?
- 9. Assembling large systems in space?
- IO. Using non-terrestrial materials (e.g., lunar ore)?

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TIMING

Which activity phase(s) do you...

- Il. Engage in presently?
- 12. Expect to be engaged in by 1985?
- 13. Expect to be engaged in by 1990?
- 14. Expect to be engaged in by 1995?
- 15. Expect to be engaged in by 2000?

n			
12			
13			
14			
15			

If the availability of a Space Station might significantly change your currently planned uses of space facilities, it will be necessary to complete an additional set of Fact Sheets — one for your current program and one to show anticipated requirements if your program is modified or expanded to make use of a Space Station. Also, it it appears that different activity phases of your product development cycle will have significantly different requirements, or if you have a number of independent products, then separate fact sheets should be prepared for each development phase or for each independent product.

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(e.g., power, ed as well a	data managemen s significant equip	interested as a provider of supporting services to Space, habitability, logistics), please describe the function(s) ment performance capabilities. Then answer any applicates Technical Parameters.	to be provid
Description o	x functions/service	s to be provided.	
orbit paylo Shuttle to lo orbit places Centaur clo to 2.000 kg	ads. The Payload A we earth orbit and a ment for spacecrations (PAM-A) provide g (4400 lb) in geo	is that provide a range of delivery capabilities for go Assist Module - Delta Class (PAM-D), for example, is de provides spin capability up to 100 rpm and geosynch weighing up to 1,088 kg (2,400 lb). The Payload Assist is spin capability up to 65 rpm and can place space are synchronous transfer orbit. The Inertial Upper Stage (elivered by the ronous transfe Module – Atla attweighing u
multiple sponding of has cape (10,600 lb) geosynchrotics, transfer needed from	acecraft up to 91 m abilities for placing in GEO. If your org mous orbit payloa r orbit or geosynch in the Space Stati Then answer any	in GEO. The Shuttle-delivered Centaur F will be able to (30 ft) long and weighing up to 6.350 kg (14.000 lb) in a spacecraft up to 122 m (40 ft) long and weighing anization is primarily interested in communications so its, please briefly describe the spacecraft weight or off ronous orbit placement requirements, any space ope on or Orbiter (e.g., checkout, EVA), and also the examplicable questions in the next section that add	place single in GEO. Centar up to 4.808 in tellites or oth her character rations suppo pected launa
muitiple spe G has cap (10,600 lb) geosynchro tics, transfer needed fro schedule. T Parameters	acecraft up to 91 m abilities for placing in GEO. If your orgonous orbit payloar orbit or geosynch in the Space Statishen answer any	. (30 ft) long and weighing up to 6.350 kg (14.000 lb) it is spacecraft up to 122 m (40 ft) long and weighing anization is primarily interested in communications so its, please briefly describe the spacecraft weight or off ronous orbit placement requirements, any space ope on or Orbiter (e.g., checkout, EVA), and also the exp	place single in GEO. Centar up to 4.808 litellites or other character rations suppoperted larunaress. Technic
muitiple spe G has cap (10,600 lb) geosynchro tics, transfer needed fro schedule. T Parameters	acecraft up to 91 m abilities for placing in GEO. If your orgonous orbit payloar orbit or geosynch in the Space Statishen answer any	(30 ff) long and weighing up to 6.350 kg (14.000 lb) in a spacecraft up to 122 m (40 ff) long and weighing anization is primarily interested in communications so is, please briefly describe the spacecraft weight or off ronous orbit placement requirements, any space ope on or Orbiter (e.g., checkout, EVA), and also the examplicable questions in the next section that add	place single a GEO. Centor up to 4.808 li tellites or oth her character rations suppo- pected larund ress Technic
mulitiple spe G has cape (10,600 lb) geosynchro- tics, transfer needed fro schedule. The Parameters	accecraft up to 91 m abilities for placing in GEO. If your orgo onous orbit payloa r orbit or geosynch in the Space State Then answer any of satellite and ope	(30 ff) long and weighing up to 6.350 kg (14.000 lb) in a spacecraft up to 122 m (40 ff) long and weighing anization is primarily interested in communications so is, please briefly describe the spacecraft weight or off ronous orbit placement requirements, any space ope on or Orbiter (e.g., checkout, EVA), and also the examplicable questions in the next section that add	place single a GEO. Centar up to 4.808 l tellites or oth ner character rations suppo- pected laruna ress Technic
mulitiple spe G has cap (10,600 lb) geosynchro itcs, transfer needed fro schedule. 1 Parameters Description and the follow d 20.	accecraft up to 91 m abilities for placing in GEO. If your orgo onous orbit payloa r orbit or geosynch in the Space State Then answer any of satellite and ope	(30 ft) long and weighing up to 6.350 kg (14.000 lb) in a spacecraft up to 122 m (40 ft) long and weighing anization is primarily interested in communications so is, please briefly describe the spacecraft weight or off ronous orbit placement requirements, any space ope on or Orbiter (e.g., checkout, EVA), and also the examplicable questions in the next section that additions support required.	place single a GEO. Centar up to 4.808 l tellites or oth ner character rations suppo- pected laruna ress Technic
mulitiple spe G has cape (10,600 lb) geosynchro itics, transfer needed fro schedule. T Parameters Description Ing the follow d 20. I 2 IO NFLUENCE	creecraft up to 91 m cibilities for placing in GEO. If your orgo onous orbit payloa r orbit or geosynch in the Space State Then answer any of satellite and ope ring barometer for 3 4 5 6 MODERATE INFLUENCE	(30 ft) long and weighing up to 6.350 kg (14.000 lb) in a spacecraft up to 122 m (40 ft) long and weighing anization is primarily interested in communications so is, please briefly describe the spacecraft weight or off ronous orbit placement requirements, any space ope on or Orbiter (e.g., checkout, EVA), and also the examplicable questions in the next section that additions support required. Telerence, please provide a numerical (1-10) answer to HEAVY INFLUENCE	place single a GEO. Centa up to 4.808 l tellites or oth ser character rations suppo- pected launa ress Technic

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TECHNICAL PARAMETERS

MISSION CHARACTERISTICS 1. C.Dit Parameters Shuttle/Spacelab and Space Station/Platform missions will typically be flown at altitudes ranging between 250 and 470 km (135 to 254 nmi), and at inclinations ranging from 28.5 to 104 degrees. Standard inclinations are 28.5 and 57 degrees. Please indicate below the orbit parameters (altitude and inclination) or range of parameters	less than 4 days 5 to 7 days 8 to 15 days 16 to 30 days 30 to 60 days 60 to 90 days 180 to 365 days 1 to 2 years 2 to 5 years greater than 5 years Estimate mission duration, if possible:
Compatible with your experiment. Any orbit is acceptable. Desired orbit parameters are leading to a littude with your experiment. Unknown Should opportunities become available for orbits at inclinations or altitudes different from your desired orbit, would your experiment objective permit use of other orbits? Please indicate below acceptable orbit parameters or range of parameters. Acceptable orbit parameters are lectination deg Altitude km or nmi Special orbits, e.g., elliptical orbit — explain in "Notes"	PHYSICAL CHARACTERISTICS 1. Weight Keeping in mind the Shuttle capabilities for payload delivery, please check (>) the estimated weight of user provided equipment (include consumables, if applicable). less than 30 kg 30 to 100 kg (220 lb) 100 to 300 kg (660 lb) 300 to 1000 kg (2205 lb) 1000 to 3,000 kg (6,615 lb) 3,000 to 5,000 g (1,025 lb) 5,000 to 14,515 kg (32,000 lb) 14,515 to 29,485 kg (65,000 lb) greater than 29,485 kg — explain in "Notes" Estimate weight, if possible.
On standard Spacelab flights, the Orbiter will remain aloft for 7 days. This duration can be extended to 30 days if the necessary provisions are added. The Space Station/Platform (with periodic resupply) can provide an unlimited mission duration. Please check (>) the mission duration required to achieve the desired objectives of your experiment.	2. Equipment Location The Shuttle/Spacelab and Space Station/Platform provide equipment mounting provisions in pressurized and unpressurized locations. Please indicate the type of mounting provisions you desire. pressurized location unpressurized location both pressurized and unpressurized unknown

NOTES.

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NOTES:

3. Pressurized Volume	6. Optical Window
If you indicated a desire for a pressurized location, please estimate the volume of pressurized equipment.	A high-quality optical window that provides viewing access to earth, deep space, and the sun can be made available to the user.
Volume m ³ , or ft ³	A high-quality optical window. is not needed by this experiment is needed by this experiment. may be needed by this experiment.
4. Equipment Size (unpressurized)	• •
The overall clearance envelope in the Orbiter cargo bay measures 18.3 m (60 ft) in length and 4.6 m (15 ft) in diameter. It you indicated a desire for unpressurized equipment location, please check (>) the estimated length of your experiment equipment as packaged for Shuttle launch and	Special physical characteristics or installation constraints — explain in "Notes"
mounted to a special support structure located in	RESOURCES
the cargo bay. (The support structure will generally reduce the cargo bay size available to the user	1 Electrical Power
equipment)	Depending on the configuration of Spacelab ele-
□ less than 2 m (6.6 ft) □ 2 m to 5 m (16.4 ft) □ 5 m to 10 m (33 ft) □ 10 m to 15 m (49 ft) □ 15 m to 18.3 m (60 ft) Estimate length, if possible. m. or	ments, the Orbiter can provide up to approximately 5 kW continuously to users. Without Spacelab, the available power increases to 7 kW. A typical Space Station/Platform could supply 10 to 40 kW or more, depending on the evolutionary phase. Please check (>) the estimated average power requirements for operating your equipment.
Estimate width, if possible	□ none
m, or ft	less than 100 watts
	☐ 100 to 500 watts ☐ 500 to 1,000 watts
5. Scientific Airlock	☐ 1 to 25 kW
The Spacelab or Space Station can carry a scientific airlock capable of extending experiments into space and retracting them. Instruments using the airlock can receive services provided by the Spacelab or Space Station. A scientific airlock.	☐ 25 to 5 kW ☐ 5 to 10 kW ☐ 10 to 20 kW ☐ 20 to 40 kW ☐ greater than 40 kW — explain in "Notes" Estimate power, if possible: ———————————————————————————————————
☐ is not needed by this experiment	Please estimate the daily energy required by your
 is needed by this experiment may be needed by this experiment 	experiment equipmentkWh/day

8

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2. Orientation/Targets	4. Pointing Accuracy
The Orbiter or Space Station/Platform can provide pointing at any desired inertial local vertical earth-fixed, or orbital object target.	Please check. (>) the pointing accuracy range required by your instrument at the interface (expressed as maximum allowable error).
Does your experiment require instrument pointing? No	□ unknown □ greater than 2 degrees □ 2 to 0.5 degree □ 0.5 to 0.1 degree □ 360 to 60 arc sec □ 10 to 1 arc sec □ less than 1 arc sec □ less than 1 arc sec 5. Pointing Stability Please check (>) the pointing stability range required by your instrument at the interface (expressed as maximum allowable error). □ greater than 360 arc sec □ 360 to 20 arc sec □ 1 to 0.1 arc sec □ 1 to 0.1 arc sec □ less than 0.1 arc sec □ less than 0.1 arc sec □ resec arc sec □ less than 0.1 arc sec □ less than 0.1 arc sec □ less than 0.1 arc sec □ less than 0.1 arc sec □ less than 0.1 arc sec □ less than 0.1 arc sec □ less than 0.1 arc sec □ less than 0.1 arc sec
Pointing will be provided by. ☐ the experiment ☐ a NASA-provided EPM ☐ unknown	
NOTES:	

It your experiment requires a specific controlled gravity level (i.e., artificial g) or range of levels.

please explain in "Notes".

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6. Real-Time Communication Coverage **ENVIRONMENTS** Communications contacts between the Orbiter or 1. Acceleration Level Space Station/Platform and ground control stations (via the Tracking and Data Relay Satellite System) Depending on orbit altitude, background acceleraare dictated by orbit parameters and Orbiter attition levels caused by atmospheric drag on the Ortude. Real-time communications will be possible for biter or Space Station/Platform will vary between 90% to 95% of the time. For normal operation of this approximately 10-4 and 10-8g. experiment, real-time communication with the Please check (>) the maximum allowable ground background acceleration level for your experi-☐ is needed ment ☐ may be needed □ 10⁴a □ 10-5g ☐ is not needed. □ 10 og □ 10.7g □ 10⁻⁸g 7. Data Management/Communications ☐ any of the above Do you need any of the following data manage-□ other — explain in "Notes" ment/communication functions from the STS. Attitude maneuvering, crew activity and sub-☐ digital tape recording system operations will induce acceleration trananalog tape recording sients in the range of 10^{-2} to 10^{-4} g for the Orbiter and display/keyboard 10-4 to 10-6g for typical Space Stations. Typical un-☐ general purpose computer manned Space Platforms will induce lower ac-celeration transients. These transients can be □ voice avoided for finite time periods by controlling crew □ timing activity and subsystem operations (i.e., tim: elining to ☐ guidance/navigation/control avoid conflicting operations). □ rendezvous caution and warning Please check (>) the maximum allowable acother services — explain in "Notes" celeration transient level for your experiment in the ☐ no data management services required on-orbit configuration, e.g., unpackaged or depioyed. 8. Data Rates □ 10⁻²g □ 10³a □ 10⁴g If your experiment needs real-time communica-□ 10⁻⁵a □ 10-6g tion, please estimate, if possible, the data rate reless than 10.7g cruirements. any of the above. ☐ Other — explain in "Notes". downlink digital rate **bps**

NOTES:

'Notes'

uplink digital rate

Other resource requirements \square - explain in

bps

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2. Ambient Pressure

As orbital altitude increases, the atmospheric pressure surrounding the Orbiter and within the cargo bay or around the Space Station/Platform will, of course, decrease.

Does your experiment require exposure to the space environment (e.g., externally mounted or in an airlock)?

	Yes	_	No
1 !	7 65		NO

If no, continue to the next question.

If exposure to the space environment is required, please check (>) the maximum atmospheric pressure allowable. (The approximate corresponding altitude is also given.)

- \Box 5 x 10⁻⁵ N/m² at 250 km (3.8 x 10⁻⁷ Torr) (135 nmi)
- ☐ 2.5 x 10⁻⁵ N/m² ct 287 km (1.9 x 10⁻⁷ Torr) (1.55 nmi)
- ☐ 1 x 10⁻⁵ N/m² ct 342 km (7.6 x 10⁻⁸ Torr) (185 nmi)
- ☐ 5 x 10⁻⁶ N/m² ct 390 km (3.8 x 10⁻⁸ Torr) (210 nmi)
- ☐ 2.5 x 10⁻⁶ N/m² at 440 km (1.9 x 10⁻⁸ Torr) (238 nmi)
- ☐ 1 x 10-6 N/m² at 512 km (7.6 x 10-9 Torr) (276 nmi)
- any of the above
- □ other explain in "Notes"

1. Contamination Sensitivity/Generation

Experiments can be influenced by environments produced by the Orbiter or Space Station/Platform or by other experiments. On the other hand, experiments can produce conditions that might influence other experiments if emitted. Please review the list below and check (>) those factors that would adversely affect your instrument or experiment or which might be produced and emitted by your experiment.

a. Particulate	 Contamination 	יעק
Sensitive		
no 🗆	waspe 🗆	yes 🗆
Emit		
no 🗆	maybe 🗆	yes 🗆
b. Gaseous (Contamination.	•
Sensitive		
no 🗆	maybe 🗆	yes 🗆
Emit		
no 🗆	maybe 🗆	yes 🗆
c. Radioacti	vity.	
Sensitive		
no 🗆	maybe 🗆	yes 🗆
Ernit		
no 🗆	maybe 🗆	yes 🗆
d. Electromo	ignetic Fields (I	(T).
Sensitive		
no 🗆	maybe 🗆	yes 🗆
Erait		
no 🗆	maybe 🗆	yes 🗆
e. Magnetic	Fleids.	
Sensitive		
no 🗆	maybe 🗆	yes 🗆
Emit	-	•
no 🗆	maybe 🗆	yes 🗆

Other environmental requirements \square — explain in "Notes"

NOTES:

GENERAL DYNAMICS Conveir Division

CREW/EXPERIMENT CONTROL

1 Crew Time

The Orbiter can provide one to four Payload Specialists to conduct experiments. Each Payload Specialist can devote about 8 to 10 hours per day to conducting experiments. The Space Station can provide a manned presence for essentially unlimited periods of 1 to 8 or more crewmen, depending on the evolutionary phase. Remembering that crew time may be needed for tasks such as activation, monitoring, controlling, equipment stowage, and results analysis, please check (>) the estimated average crew hours per day required by your experiment.

mated average arew hours per day required by your experiment
none less than 0.5 hr/day 1 to 2 hr/day 2 to 4 hr/day 4 to 8 hr/day 8 to 16 hr/day 16 to 32 hr/day 32 to 64 hr/day 64 hr/day 64 hr/day 67 nr/day 68 to 16 hr/day
□ Special crew requirements — explain in "Notes"
2 Crew Training
STS crewmembers can be provided by NASA and given specialized training for operation of the experiment equipment, or suitably trained representatives can be provided by the user. Please check (ν) the appropriate crew training method(s) and indicate number of crew members required.
crewmember(s) not required. NASA-provided crewmember(s) No. required user-provided crewmember(s) No. required
□ unknown

3. Experiment Control

Experiment operations ca	n be co	ntroll	ed o	n-board
or by digital commands	issued	trom	the	ground
Please check (>) the app	licable	meth	od(s	1).

☐ by on-board crew
☐ by on-board computer
☐ by digital command from ground
☐ no control required

Experiment operations can vary from simple to highly complex. Please check (ρ) as applicable.

	•				
	periment:	sequires.	ouly "	on/off"	
□ e1	periment:				ned contro
	rperiment: re control	iedmies	manı	ied, red	n-mue ac-
	her unique "Notes".	control	. requi	rement	s — explain

4. Extravehicular Activities (EVA)

The Orbiter or Space Station provides the systems and personnel needed to perform manual tasks outside the pressurized work area.

EVA can be used for operation of equipment, deployment, positioning, and retraction of booms, cargo transfer, etc.

Please check (>) one.

EVA is not needed for the normal operation
of this experiment.
EVA is needed for the normal operation of
this experiment.
EVA may be needed for normal operation of
this equipment.

Other crew-related requirements - explain in

"Notes".

NOTES.

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SPACE OPERATIONS/LOGISTICS

1 Space Operations

The STS could offer a wide variety of space operations functions for users, or the functions could be provided by your equipment. Do you anticipate use of, or would you provide any of the following typical functions?

Construction	use 🗆	provide
Assembly	use 🗆	provide
Alignment	use 🗆	provide
Service		provide 🗆
Maintenance	use 🗆	provide
Checkout	use 🗆	provide
Deploy	use 🗆	provide
Retrieve	use 🗆	provide
Dock	use 🗆	provide
Propellant		
handling	use 🗆	provide
Propellant		•
storage	use 🗆	provide
Space operation	tunctions may b	e needed 🗆;
provided		
Space operation	n functions are no	ot needed 🗆
not provided \square		
other space	operations — ex	plain in "Notes"
If you indicated	use of, or provisi	on of any space
operations fund	tions, briefly de	ecribe the char-
acteristics or limi	itations in "Notes"	(e.g., type/size or
trequency of ins	trument servicing	or maintenance,
the propellant ty	pe (H2, O2, N2H4	etc.) or propellant
		turne / size or fre-

quency of items to be deployed or retrieved.)

NOTES:

2 Logistics

Do you anticipate the need to resupply materials or expendables or return samples/products?

Resuppi	maybe □	yes 🗆	
Return to	o Ecarth maybe □	yes 🗆	
nature of	upport is anticipe support in term and frequency in EXPERIMEN	ns of item type "Notes".	
L Storag	•		
	quire storage pro i products, tilm, e		materials
no 🗆	maybe 🗆	yes 🗆	
il storage quiremen	is needed, plea is.	me describe st	orage re-
			
	quire special pro retrigeration, ligi		trom the
no 🗆	maybe 🗆	yes 🗆	
requirements	on is needed, ple ents	ease describe ;	protection
Does you	experiment inv	olve live speci	mens?
no 🗆	_		
If live spec port requi	zimens are invol rements :	ved, please des	cribe sup-

Other experiment support \square — explain in "Notes"

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SAPETY

NOTES.

l Potential Hazard	.
	ny of the following potential classed with your experiment.
high pressure pyrotechnics radiation cryogenics propellants corrosive toxic substances other — explain	
OTHER ACCOMMO	DATION CONSIDERATIONS
1. Experiment Con	apatibility/Flexibility
	et such a nature that it would conducted in isolation from
no 🗆 maybe 🖰] yes □
Would isolation in destrable? (e.g., use a	rom other equipment be (a tree flyer)
no 🗆 maybe 🗈] yes [
	ial isolation requirements.
ceptable accommod	eral-purpose facility be an ac- dation for your experiment? Mary process security, etc)
no 🗆 maybe 🛚	□ yes □
Special accommodo plain in "Notes"	ntion considerations - ex-
	MAILING INSTRUCTIONS
	When completed please return this questionnaire to
	General Dynamics Convair Division Space Station Project, MZ 21-9530 P.O. Box 80847 San Diego, CA 92138